

BLM LIBRARY



88018622

# **WORK PLAN FY '79**

# **EMRIA**



A Cooperative Agreement...  
U.S. GEOLOGICAL SURVEY  
BUREAU OF LAND MANAGEMENT



# 21013857  
88018622

TABLE OF CONTENTS

BLM LIBRARY  
SC-324A, BLDG. 50  
DENVER FEDERAL CENTER  
P. O. BOX 25047  
DENVER, CO. 80225-0047

GR  
658.7  
-L362  
1979

SUMMARY OF FUNDS . . . . .

AGREEMENTS

Water Resources Division . . . . .	1
Branch of Coal Resources . . . . .	84
Branch of Regional Geochemistry . . . . .	97

WATER QUALITY PARAMETERS

Alabama . . . . .	9
New Mexico . . . . .	45
North Dakota . . . . .	55
Oklahoma . . . . .	65

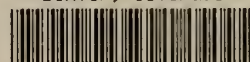
DISTRIBUTION OF FUNDS

WATER RESOURCES DIVISION

<u>State</u>	<u>Page</u>	<u>Activity</u>	<u>Cost</u>
Alabama	3	Hydrologic Modeling	\$ 45,600
	5	Hydrologic Data Collection	119,700
		Total	\$ 165,300
Colorado		Hydrologic Modeling	
	12	Foidel and Middle Creeks	\$ 55,000
	13	Taylor, Wilson, Jubb Basin	48,500
	14	Hayden Gulch	56,500
	15	Raton Mesa	110,000
	16	Ground Water Level Monitoring	100,000
	16	Hydrology Coal Spoil Piles	65,000
	18	Hydrology North Park	40,000
	19	Hydrology Raton Mesa	60,000
		Colorado River Salinity	
	20	Badger Wash	16,000 <u>1/</u>
	21	Colorado Water Quality Stations	74,760 <u>1/</u>
	22	Salt and Onion Creek	
		Investigations	63,440 <u>1/</u>
	24	Continuation of Colorado	
		Groundwater Study	16,400 <u>1/</u>
	24	Climate Station in North Park	
		(McCallum), and 1 in Craig Area	38,000
	25	Operation of Hydrologic Stations,	
		San Luis Valley	17,500 <u>2/</u>
		Total	\$ 761,100

1/ Salinity Project Funds  
2/ State Funds

BUREAU OF LAND MANAGEMENT LIBRARY  
Denver, Colorado



88018622

<u>State</u>	<u>Page</u>	<u>Activity</u>	<u>Cost</u>
Montana		Hydrologic Data Collection	
	26	Streamflow and Chemical Quality	\$ 147,700
	27	Sediment	10,500
	28	Hydrologic Modeling	70,000
	29	Ground Water Monitoring	46,000
	30	Construction Observation Wells	23,000
	31	EMRIA Site Studies	120,000
	32	Evaluation Surface Water Quality	56,000
	33	Well Inventory	37,000
		Grants	
	34	Test Drilling and Aquifer Testing	90,000
	35	Benthic Study of Streams	26,000
	35	Sulfur Cycle Study	17,000
	36	Reservoir Sampling	32,250 <u>2/</u>
		Total	\$ 675,450
New Mexico	40	Hydrologic Modeling	\$ 46,000
	41	Watershed Characterization	24,000
	42	Hydrologic Surveillance	130,000
		Total	\$ 200,000
North Dakota		Hydrologic Modeling	
	47	Beulah Trench	\$ 66,400
	49	Wibaux-Beach	71,000
	51	Hydrology Rattlesnake Butte	151,000
	53	Hydrology McKenzie County	6,400
		Total	\$ 294,800
Oklahoma		Hydrologic Monitoring	
	58	Blocker Area	\$ 44,500
	58	Rock Island Area	28,100
	59	Red Oak Area	56,000
	59	Stigler Area	47,700
	60	Lehigh Area	91,700
	64	Sediment Monitoring	79,800
		Total	\$ 347,800
Oregon	67	Ground Water Inventory	\$ 4,000 <u>2/</u>
		Total	\$ 4,000

2/ State Funds

<u>State</u>	<u>Page</u>	<u>Activity</u>	<u>Cost</u>
Utah	68	Ferron Sandstone	\$ 192,000
	69	Uinta Basin (White River Gage)	12,200
	70	Price River Basin	107,000
	71	Hydrology of the Central Wasatch Plateau	107,000 <u>2/</u>
	72	Hydrologic Monitoring	7,600 <u>2/</u>
		Total	\$ 425,800
Wyoming		Hydrologic Monitoring - Surface Water Network	
	74	Powder River Basin	\$ 56,410
	75	Green River, Great Divide, and Bear River Basins	101,800
	76	Hanna Basin	24,540
	77	Big Horn and Platte Basins	45,550
		Total	\$ 228,300
Central Region		Public Lands Hydrology	
	79	Hydrologic Modeling	\$ 128,700
	80	Rainfall-Simulation	35,000 <u>3/</u>
	82	Channel Geometry	110,000
		Total	\$ 273,700
		GRAND TOTAL	\$3,376,250

#### BRANCH OF COAL RESOURCES

North Dakota	86	Beulah Trench	\$ 1,500
	87	Rattlesnake Butte	21,000
Montana	88	Prairie Dog Creek	22,000
Colorado	89	Lay Creek	18,000
	90	McCallum	23,000
New Mexico	91	Kimbeto	2,000
	92	Ojo Encino	22,000
Utah	93	Emery	28,000
Oklahoma	94	Arkoma Basin	27,500
Alabama	95	Northern Alabama	40,000
Eastern & Western Sections	96		25,000
		GRAND TOTAL	\$ 230,000

2/ State Funds

3/ Watershed Funds

BRANCH OF REGIONAL GEOCHEMISTRY

<u>State</u>	<u>Page</u>	<u>Activity</u>	<u>Cost</u>
Oklahoma	97		\$ 76,500
Utah	97		21,000
Alabama	97		2,500
GRAND TOTAL			\$ 100,000

# SUMMARY OF FUNDS

## BLM Costs

### WATER RESOURCES DIVISION

State	EMRIA	Salinity	Watershed	State	Total Cost
Alabama	\$ 165,300				\$ 165,300
Colorado	573,000	\$170,600		\$ 17,500	761,100
Montana	643,200			32,250	675,450
New Mexico	200,000				200,000
North Dakota	294,800				294,800
Oklahoma	347,800				347,800
Oregon				4,000	4,000
Utah	311,200			114,600	425,800
Wyoming	228,300				228,300
Central Region					
OPLH	128,700		\$35,000		163,700
Channel Geometry	110,000				110,000
TOTALS	\$3,002,300	\$170,600	\$35,000	\$168,350	\$3,376,250

### BRANCH OF COAL RESOURCES

\$230,000

### BRANCH OF REGIONAL GEOCHEMISTRY

\$100,000





## **WATER RESOURCES DIVISION**



## ANNUAL WORK PLAN

### USGS WATER RESOURCES DIVISION AND BLM (EMRIA) Fiscal Year 1979

#### AUTHORITY

The General Agreement between the Bureau of Land Management (BLM) and the Geological Survey (GS), dated August 15, 1974, is considered an integral part of the Work Plan.

#### PURPOSE

The purpose of this work order is to specify the nature and amount of assistance to be provided by GS to BLM under the EMRIA program during FY 79.

#### SCOPE

This work order includes all services to be provided by the GS under the EMRIA progra to BLM in fiscal year 1979 in the States of Alabama, Colorado, Montana, New Mexico, North Dakota, Oklahoma, Utah, and Wyoming.

The GS will provide the services, including personnel, equipment, supplies, and facilities to conduct water resources investigations in areas designated by the BLM. Services will include installation, operation, and maintenance of surface-water gages, ground-water wells, and climate stations as well as water-quality collection and analysis. Detailed descriptions of all studies in the eight states are presented in "Annual Work Plan for the BLM (EMRIA)/GS Water Resources Investigations - FY 79" which is considered an integral part of this work order.

#### PROCEDURE

Fiscal year 1979 is the fifth year of this cooperative effort. Some work that began in earlier fiscal years will be continued in fiscal year 1979, while some projects may be dropped. New studies will begin in fiscal year 1979, some of which will carry into fiscal year 1980 and beyond. These decisions will be made in joint meetings among the GS district and state offices and the Denver Service Center. The annual work plan is developed by D-307 after negotiations with BLM field offices to determined needs and GS field offices to determine capabilities, recommended hydrologic procedures, and for coordination with other studies conducted by the GS in other programs. The development of budgets takes into account the program needs of both bureaus and funds available to meet those needs. When mutual interests are are strong, funds from both bureaus are applied. Funds tabulated in the work order, however, represent only those from BLM.

Field investigative procedures will be standard GS water resources investigation techniques.

## REPORTS

Reporting will generally be standard GS report procedures with some deviations that are detailed in the Annual Work Plan.

## FUNDING

BLM will reimburse GS for actual expenses incurred in providing the service covered in this work order, not to exceed \$3,376,250, upon receipt of SF 1081. Details of cost items for each study in each state are presented in the Annual Work Plan. A summary of costs by state is presented below.

### SUMMARY OF COST ESTIMATES BY STATE

Alabama	\$ 165,300
Colorado	761,100 <u>1/</u>
Montana	675,450 <u>2/</u>
New Mexico	200,200
North Dakota	294,800
Oklahoma	347,800
Oregon	4,000 <u>3/</u>
Utah	425,800 <u>4/</u>
Wyoming	228,300
Public Lands Hydrology (all states)	163,700 <u>5/</u>
Channel Geometry (all states)	<u>110,000</u>
Total	\$3,376,250

- 1/ Contains \$188,100 non-EMRIA funds
- 2/ Contains \$32,250 non-EMRIA funds
- 3/ Contains \$4,000 non-EMRIA funds
- 4/ Contains \$114,600 non-EMRIA funds
- 5/ Contains \$35,000 non-EMRIA funds

**Alabama**



## ALABAMA

### I. Hydrologic Modeling

- A. Location: The Warrior Coal Field is the principal area of study which includes parts of Walker, Fayette, Tuscaloosa, and Jefferson Counties, an area of about 3,900 square miles.
- B. Objective: Collect and interpret basic data on water resources to aid the Bureau of Land Management in its responsibility for preparation of environmental impact statements and in its planning and management of coal reserves underlying Federally controlled mineral rights, and to collect hydrologic data to meet the needs of hydrologic modeling. The interpretation of the data collected is divided into three phases to determine the following:
  - 1. Hydrologic characterization of selected basins.
  - 2. Effect coal mining will have on the hydrology.
  - 3. Assess the reclamation practices by reviewing literature and personal contacts on the various reclamation practices presently performed in Alabama; and the evaluation of data collected as a part of Federally financed coal hydrology project AL 75-034.
- C. Procedures: Twenty-one surface-water resources data collection sites have been established in selected basins in the Warrior Coal Field. Data collection started in October 1976 will be continued during FY 79. Data collected at three additional sites as part of AL 75-034 will be incorporated into this project financed by WRD. The evaluation of these data are being used to determine seasonal changes prior to mining operations and continued during mining operations to assess the effect that mining has on the hydrologic system. The four basins monitored are in Tuscaloosa County, Blue, Bear, Turkey, and Yellow Creeks.
  - 1. Bear and Blue Creek basins are in an area where the surface geology is predominantly weathered sandstone and shale that occurs above the coal seams in the Pottsville Formation. Turkey and Yellow Creek basins are in an area in which there is a high percentage of unconsolidated sand of Cretaceous age overlying the coal seams in the Pottsville Formation. Mining is expected to start in these areas in less than 1 year, and data obtained from these basins will have transfer value to similar areas within the Warrior Coal Field.
  - 2. Continue operation of two continuous-record stations equipped with surface water-level recorders, rain gages, automatic sediment samplers, and water-quality monitors, measuring temperature and specific conductance. In addition to these stations, the three additional stations operated as part of project AL 75-034 will obtain the same type of data.

3. A network of observation wells, utilizing existing wells, was completed in FY 77. Test drilling (funded by USGS) started on June 6, 1978 to fill the gap in existing wells to meet the needs for an adequate observation-well network. A minimum of 21 wells will be drilled and recorders will be installed on at least six of the wells.
4. Water-level measurements and water-quality sampling started on March 1, 1977 will be continued and greatly expanded to include the new wells that are being drilled. Constituents determined at the start of sampling, semiannually, and when significant hydrologic changes occur are noted. Short pumping tests and possibly slug tests will be made.
5. Continue to tabulate and interpret on a current basis all water-quality, sediment, biologic, geologic, and meteorologic data pertaining to baseline conditions prior to mining and to assess any changes resulting from mining as it develops.
6. Continue to contract work for aerial photography of the four basins. A total of slightly more than 300 square miles was completed in FY 78. The photographs will aid in determining the percentage of areas in the basin that are mined, the land use, the location of timber trails, etc.
7. Climatic data collection has been expanded from two to seven precipitation stations. All of the stations are equipped with ADR's with 5-minute cams. A weather station, which records precipitation, relative humidity, solar radiation, wind speed and direction, and maximum and minimum air temperature, is in operation. A soil moisture data collection network will also be operated. A permit has been obtained from the Nuclear Regulatory Commission and selected personnel in the Tuscaloosa Subdistrict office are to be trained in the operation of a portable depth moisture probe.
8. Continue coordination with other agencies to avoid duplication of data collection and to inform other agencies of the objectives of the project and the data being collected. Meetings or discussions have been held with the following agencies or firms: Alabama Water Improvement Commission, Geological Survey of Alabama, West Alabama Planning and Development Council (responsibility for 208 project, Tuscaloosa County), Bureau of Mines, and University of Alabama, Gulf States Paper Corporation, Warrior River Coal Company, Odell Mining Company, Soil Conservation Service, Environmental Protection Agency, U.S. Forest Service, MESA, Drummond Coal Company, Alabama Development Office, Blackjack Mining Company, Environmental Center, University of Tennessee, Alabama Highway Department, Program report to all Federal and State Water Agencies, Alabama Health



Department, Tennessee Valley Authority, Alabama Power Company, Water Resources Research Institute, National Weather Service, Carbon Fuel Company, Inc., Birmingham Regional Planning Commission, University of Alabama (Biology and Geology Departments and School of Mines). BLM personnel opened an office adjacent to this space on March 1, 1977. This arrangement is fostering close working relations between the two offices. Progress conferences continue with BLM personnel for the purpose of reviewing status of project activities and the availability of data required for preparation of EIS statements.

9. In addition to the two continuous-record stations, monthly streamflow measurements, water quality, and biologic sampling will be done at five partial-record stations, and streamflow, water quality and sediment data will continue to be collected at least twice per year during FY 79 at 16 stations. More emphasis will be placed on collecting data at the partial-record sites during flood events.

Two reconnaissance water-quality runs will be made over the entire Warrior Coal Field. Samples will be collected from old and new mined and unmined sites for standard analyses, total and dissolved aluminum, iron, and manganese, and nitrogen and phosphorus species to facilitate regionalization of quality of water. The biologic sampling phase of this study consists of measuring parameters that are indicative of the effects of acid mine drainage. Biologic sampling is being done in sections of streams at or near riffle areas and in pools at four of the eight regularly visited sites as sediment deposition in pools will have the first noticeable effects on the biologic community. Sampling at riffles is done monthly and in pools quarterly.

D. Current Data Collection:

1. Surface Water: Discharge, chemical quality, biologic and sediment.
2. Ground Water: Information on wells, aquifer yield, water use, water levels, chemical quality, water availability, occurrence, and movement.
3. Weather: Rainfall amount, distribution, and chemical character, relative humidity, solar radiation, wind speed and direction, maximum and minimum temperature.
4. Soil Moisture:
5. The collection of data at the seven sites previously selected will continue to be done monthly and as dictated by weather conditions. As a means of expediting this phase of the project, the following summary, giving basic data needs, procedures, and manpower needs for data collection follows:

a. Regular Monthly Data Collection and Procedures:  
Continue data collection and procedures as follows:

- (1) Stream Discharge: Measure each site during each visit in order to establish stage-discharge relationship throughout the flow regime.
- (2) Sediment: Collect sample during each visit to determine suspended sediment concentration.

Additional sediment samples for particle size will be collected at predetermined intermittent intervals. Standard procedures outlined in TWRI Book 3, Chapter 2C will be used in sample collection.

- (3) Chemical Quality: Field determinations of pH, specific conductance, bicarbonate, dissolved oxygen, and temperature will be made during each visit.
- (4) The regular monthly data collection program as stated above shall apply to the following sites:

<u>Station No.</u>	<u>Station Name</u>
(1) 02462980	Yellow Creek above Northport, Ala.
(2) 02462985	Unnamed tributary to Yellow Creek near Northport, Ala.
(3) 02462990	Yellow Creek near Northport, Ala.
(4) 02463890	Dry Branch near Samantha, Ala.
(5) 02463900	Bear Creek near Samantha, Ala.
(6) 02464145	Turkey Creek near Tuscaloosa, Ala.
(7) 02462991	Tributary to Yellow Creek above Watermelon Road near Tuscaloosa, Ala.

Sediment samples will be collected in a minimum of ten verticals using the ETR method.

b. Data Collection and Porcedures for Flood Events:

- (1) Stream Discharge: Make as many measurements as needed to rate the gaging station site throughout the entire flow regimen.
- (2) Sediment: Samples are collected manually before the rise and during the rise, peak, and recession of the peak. During the rise, peak, and recession, sampling is done at least once each hour and in some instances as often as possible, depending on

the individual rise characteristics. For stations with installed automatic sediment samplers, one sample is normally collected per day during base flow conditions; during a flood event, the samplers are set to collect samples per half foot change in river stage during the entire flood event. Samples will be collected manually at different stages until the relationship between sediment discharge obtained by sampling manually and by the automatic sediment sampler is determined. Samples are collected in a minimum of ten verticals using the ETR method. Use standard procedures as outlined in TWRI Book 3, Chapter 2C.

- (3) Chemical Quality: Depth integrated samples for chemical quality are collected across the stream cross section at about ten verticals. The specific conductance, pH, and temperature are determined and recorded for each sample. If a 20 percent change in conductance is noted between current and previous sample or a rise of 1 foot occurs, additional flood water quality variables are sampled. A field determination of bicarbonate is completed before the rise, if time permits; otherwise, bicarbonate is determined as part of the laboratory analysis.

The parameters and the frequency of sampling change with time, as the data received from these sites are evaluated, and changes are made during the course of the project depending on the significance of the results and the adequacy of the data collected.

- E. Report Products: All data collected as a part of the project will be placed in computer storage on an ongoing basis. All baseline data will be published in annual reports of the U.S. Geological Survey. A progress report will be ready for District review by September 1978. A final report outlining baseline conditions and the effect of coal mining on the hydrology of the area will be prepared at the termination of the project. During the course of the study, interpretations of the data obtained from the project will be incorporated into papers presented to professional organizations that deal with coal mining. A review of progress of other State and Federal agencies' activities in coal mining projects will be made on a periodic basis to keep abreast of the activities so that phases of this investigation will not duplicate ongoing projects. Those agencies that are currently involved in this type of activity include the Geological Survey of Alabama, the University of Alabama Research Department, Alabama Water Improvement Commission, and NASA.

F. Distribution of Funds: A breakdown of expenditure of funds planned for FY 79 and the allocation of money from BLM follows:

Salaries	\$114,460
Travel	2,890
Aerial Photography	1,500
Data Porcessing	6,000
Laboratory Services	28,900
Equipment and Supplies	<u>11,550</u>
Total	\$165,300 <u>1/</u>

1/ Does not include \$56,300 from WRD for continuation of biologic work described in previous section.

## ALABAMA

### LIST OF WATER QUALITY PARAMETERS

Constituents to be Determined at any Time a Large  
Change in Chemical Characteristics Occur

Silica	Hardness, noncarbonate
Iron	Acidity
Manganese	Sodium absorption ratio
Calcium	Specific conductance
Magnesium	pH
Sodium	Temperature
Potassium	Color
Bicarbonate	Arsenic
Carbonate	Cadmium
Sulfide	Chromium
Sulfate	Cobalt
Chloride	Copper
Fluoride	Lead
Nitrogen, nitrate, total	Lithium
Nitrogen, total Kjeldahl	Mercury
Phosphorus, total	Selenium
Dissolved solids	Strontium
Hardness, calcium-magnesium	Zinc

Constituents to be Determined Semiannually

Iron	Hardness
Bicarbonate	Specific conductance
Carbonate	pH
Sulfate	Temperature

# Surface-Water Chemical Quality Sampling Program

<u>Constituent or Description</u>	<u>Semiannual</u>	<u>Quarterly</u>	<u>Monthly</u>
Discharge, ft <sup>3</sup> /s			X
Silica		X	
Iron		X	
Manganese	X		
Calcium		X	
Magnesium		X	
Sodium		X	
Potassium		X	
Bicarbonate			X
Carbonate			X
Sulfide		X	
Sulfate			X
Chloride		X	
Fluoride		X	
Nitrogen, nitrate, total		X	
Nitrogen, nitrite, total		X	
Nitrogen, total Kjeldahl		X	
Phosphorus, total		X	
Phosphorus, orthophosphate		X	
Dissolved solids		X	
Hardness, calcium-magnesium		X	
Hardness, noncarbonate		X	
Acidity		X	
Sodium absorption ratio		X	
Specific conductance			X
pH			X
Temperature			X
Color		X	
Dissolved oxygen		X	
Specific conductance/sulfate			X
Aluminum		X	
Organic carbon, total	X		
Carbon, total	X		
Phenols	X		
Arsenic	X		
Boron	X		
Cadmium	X		
Chromium	X		
Cobalt	X		
Copper	X		
Lead	X		
Lithium	X		
Mercury	X		
Selenium	X		
Strontium	X		
Zinc	X		
Gross Alpha, Beta radionuclides	X		
Radium 226	X		
Uranium	X		

# Surface-Water Biological Quality Sampling Program

<u>Description</u>	<u>Quarterly</u>	<u>Monthly</u>
Periphyton		
Algal identification		X
Chlorophyll		X
Biomass		X
Benthic Invertebrates		
Type II	X	X
Adenosine Triphosphate		X





**Colorado**



I. Hydrologic Modeling

- A. Objectives: The objective of this program is to define the hydrologic system of the basin, interrelating surface-water flow, ground-water movement, precipitation, and climate. The availability and quality of surface and ground water will be defined. This information will be related to present and future mining operations to assess the affects of mining on basin hydrology. This program will provide data for the total assessment of the mining.

For FY 79 the hydrologic monitoring program will be continued. Data on surface-water quantity and quality, ground-water quality and potentiometric surface levels, and area climate will be collected. Convertible Data Collection Platforms (CDCP) have been installed at the climate stations on Foidel and Taylor Creeks to facilitate more rapid and complete data collection and reduction. Available data from new observation wells from governmental and private drilling programs will be obtained for completing the area observation well network. Initial hydrologic modeling will be attempted in order to evaluate the data monitoring program.

B. Study Watersheds:

1. Foidel and Middle Creek: Three surface-water gaging stations are operated. Discharge, water temperature, and specific conductance are continuously monitored at each station. Monthly water samples are collected at each station to be analyzed for major chemical constituents. Water samples are collected quarterly at each station and analyzed for trace metals. Monthly sediment samples are collected at the upper Foidel Creek and the Middle Creek stations. Sediment samples at the lower Foidel Creek station are collected by an automatic suspended sediment sampler.

A climatological station is operated on Middle Creek. <sup>3</sup>  
Precipitation, air temperature, relative humidity, soil temperature, wind, and solar radiation are measured at this site. A second precipitation gage is operated on the rehabilitation study area, and a third precipitation gage is installed at the mouth of Foidel Creek. Snow course data are also being collected.

3  
5  
- 2  
6  
5  
10  
Three deep wells (about 400 feet deep), and five shallow alluvial wells (about 50 feet deep) were drilled in the study area. Two shallow wells were abandoned and six wells were completed as observation wells. Five wells drilled by

the Bureau of Reclamation on the Bureau's reclamation study site are completed as observation wells. Water levels are measured quarterly in each observation well.

a. Distribution of Funds:

Salaries	\$30,630
Travel	4,150
Laboratory Analyses	15,600
Data Processing	<u>4,620</u>
Total	\$55,000

2. Taylor, Wilson, Jubb Creek Basin: Two surface-water gaging stations are installed which, including two existing stations, brings the total number of gaging sites in the area to four. Operation of three gaging stations on Wilson, Taylor and Jubb Creeks is funded by the Bureau of Land Management. Discharge, water temperature, and specific conductance are continuously monitored at each station. Monthly water samples are collected at each station and analyzed for major constituents and trace metals. Monthly sediment samples are collected at the Taylor and Jubb Creek stations. An automatic suspended-sediment sampler is installed at the Wilson Creek station.

A climatological station is operated in Wilson Creek basin. Air temperature, relative humidity, precipitation, soil temperature, wind and solar radiation are measured at this site. A second precipitation gage is operated in the head-waters of Wilson Creek. A third precipitation gage is scheduled to be installed on the Taylor-Wilson Creek divide after the Colowyo mining plan has been finalized. Snow course data are also collected.

One deep well (about 400 feet) was drilled in Wilson Creek drainage. Twelve additional wells drilled to bedrock by W. R. Grace, the Bureau of Reclamation, and the U.S. Geological Survey were completed as observation wells. All wells were tested to determine the hydraulic properties of the alluvial and deeper aquifers. Water levels are measured quarterly in each observation well.

a. Distribution of Funds:

Salaries	\$25,220
Travel	3,820
Equipment (replacement)	1,090
Laboratory Analyses	14,000
Data Processing	<u>4,370</u>
Total	\$48,500

3. Hayden Gulch: For FY 79 the hydrologic monitoring program will be continued. Data on surface-water quantity and quality, ground-water quality and potentiometric surface levels, and area climate will be collected. New observation wells from governmental and private drilling programs will be obtained if available for completing the area observation well network.

This area has been chosen to complete the hydrologic network for northwestern Colorado. Hayden Gulch lies between Foidel-Middle and Taylor-Wilson Creeks.

Hubberson Gulch and Watering Trough Gulch were selected as basins with proposed coal development. A third basin, Stokes Gulch, was selected as being representative of the dryland-farming areas of the region. Stokes Gulch will provide data to compare the hydrologic impacts of coal development with those of agriculture in the Yampa Basin.

A surface-water gaging station is installed on Stokes Gulch. Discharge, water temperature, and specific conductance will be continuously monitored. Monthly water samples will be collected and analyzed for major chemical constituents. Quarterly water samples will be collected and analyzed for major constituents and trace metals. Monthly sediment samples will be collected at the Hayden Gulch stations. Sediment samples at the Stokes Gulch station are collected by an automatic suspended-sediment sampler.

A climatological station will be installed in the Hubberson and Watering Trough Gulch area. Precipitation, air temperature and relative humidity will be measured at this site. A second precipitation gage has been installed in the Stokes Gulch basin.

Landowner problems plague the installation of surface-water gages on Hubberson and Watering Trough Gulches. For these sites, however, monthly water samples, sediment samples, and discharge measurements were obtained. The monthly water samples collected were analyzed for major chemical constituents.

Three observation wells in the Hubberson-Watering Trough Gulch area, made available by Peabody Coal Co., were sampled; in addition, two observation wells drilled by the Conservation Division were sampled. No additional wells to be drilled by the Conservation Division are planned to be used as observation wells.

a. Distribution of Funds:

Salaries	\$30,663
Travel	3,526
Laboratory	19,421
Data Processing	<u>2,890</u>

Total	\$56,500
-------	----------

4. Raton Mesa: For FY 79 the hydrologic monitoring program will include the installation and operation of two detailed site-specific study areas. The study sites were selected based on their representativeness of areas to be surface mined, and their potential for being mined within the next three to five years. The sites selected were Mulligan, Carprios, and Molino Canyons.

Surface water gaging stations with concrete flumes were installed on all three basins. Monthly water samples will be collected at each station and analyzed for major chemical constituents. Quarterly water samples will be collected at each station and analyzed for major constituents and trace metals. Sediment samples were collected by automatic suspended-sediment samplers.

A climatological station will be installed in Mulligan and Molino canyons. Each station will measure air temperature, relative humidity, precipitation, soil temperature, wind and solar radiation.

The development of an observation well network has been initiated through the Ground Water Monitoring in Coal Bearing Formations program (Section II).

A field reconnaissance water quality survey is planned for the area. This survey will sample a wide variety of streams to augment the monitoring program.

a. Distribution of Funds:

Salaries	\$ 30,638
Travel	4,624
Equipment	5,375
Laboratory	20,231
Drilling	46,242
Data Processing	<u>2,890</u>

Total	\$110,000
-------	-----------



- C. Reports: Interim results and data will be published in an interagency, interdisciplinary report. Final results will be published at the conclusion of the study, three to five years hence.

## II. Ground-Water Level Monitoring, Coal-Bearing Formations in Colorado

- A. Location: Colorado
- B. Objectives: The objective of this program is to define seasonal and annual water-level fluctuations in the major coal-bearing Formations throughout the Colorado coal regions. These data are essential for mapping the potentiometric surface and for evaluating the ground-water hydrology and potential impacts of comprehensive chemical analyses.

In cooperation with the Geologic and Conservation Divisions of the USGS, the U.S. Bureau of Mines, Colorado Fuel and Iron Corporation, and Mobil Oil Corporation, additional wells have been made available for the observation well network. Also, logs from these various sources have been obtained and interpreted for sandstone thickness, relative porosity, and estimated specific conductance. So far in the program, 127 wells have been drilled.

Water quality analyses of some of these wells is being initiated. Also, water level recorders will be installed on six wells.

- C. Report Products: A data report on characteristics of the wells in the network will be prepared in FY 79.
- D. Distribution of Funds:

Salaries	\$ 24,280
Travel	6,127
Laboratory Costs	32,369
Drilling and Pump Tests	23,352
Data Processing	2,312
Equipment	<u>11,560</u>
Total	\$100,000

## III. Hydrology and Reclamation Potential of Coal Spoil Piles

- A. Location: Routt County, Colorado
- B. Objectives: The objectives are three-fold. First, the hydrologic characteristics of coal spoils piles will be defined. The quantity, quality, and timing of water movement through the spoils will be examined and compared to the same parameters for undisturbed basin areas. The hydrologic data collected will be used to develop a model to predict the impact of coal development on the quantity

and quality of water leaving a mined basin. In addition, the model will aid in the assessment of the reclamation potential of disturbed areas by providing a complete annual water balance for those specific areas of a basin.

The second objective will be the assessment of the use of cuttings from holes drilled in undisturbed areas to predict the water-quality changes that will occur after mining of these areas. Water-quality changes in existing spoils piles will be compared to quality changes in water passed through a column of cuttings from areas adjacent to the spoils. This technique would provide a relatively inexpensive method for predicting water-quality changes in areas to be mined. These data would then be used in the hydrologic simulation model to predict the impact of mining on total basin hydrology.

The third objective is to examine the effects of various reclamation procedures on spoils piles hydrology. Different land surface treatment and vegetative covers will be applied and evaluated as to their effectiveness in reclaiming disturbed areas, their specific water requirements, and their impact on water quality. This objective will not be examined until objective one is met.

The hydrology of spoils piles is monitored using a combination of lysimeters and observation wells. Lysimeters are installed in the upper 8 feet of the spoils profile. Five lysimeters are installed in a reclaimed spoils area and two lysimeters will be installed in an undisturbed area. A rainfall simulator is used to obtain deep percolation samples for quality and quantity analyses from four lysimeters in the spoils area. It will be used on one lysimeter in the natural area. Because the rainfall simulator produces an above-average water movement through the profile, one lysimeter in each area is used to monitor hydrologic response under natural conditions. The rainfall simulator will permit determination of the hydrologic characteristics of spoils, the validity of induced versus natural lysimeter response, and the effects of various reclamation treatment on spoils hydrology. Soil-water regimes within the lysimeter and areas adjacent to the lysimeter are monitored using access tubes and a neutron soil moisture probe.

One to three holes will be drilled in the existing spoils pile to total mined depth (about 150 feet). Three holes have been drilled to an equivalent depth in adjacent undisturbed areas. All holes will be completed as observation wells and periodic water samples will be collected for analysis of major chemical constituents and selected trace metals. Water-quality changes within the total depth of spoils will be determined from these samples. Cuttings from each hole will be collected and used to construct laboratory columns which are representative of the holes from which the cuttings came. Water will be passed through



the columns at various flow rates, and water samples will be collected at predetermined times during the column runs. Analyses of water samples from the column runs will be related to the results of lysimeter runs and the sample analyses for the observation wells in the spoils. Relationships developed between water-quality changes in the columns and those observed in the field will show the feasibility of a rapid, relatively inexpensive method for predicting water-quality changes in areas to be mined.

Once the hydrology of the lysimeters in the spoils area are defined, various reclamation treatments will be imposed. The rainfall simulator will be used to stress these treatments. The effects of these treatments on water use, runoff, and water quality will be determined.

- C. Report Products: A 100-page Water Resources Investigations Report is due in 1979 entitled "Inventory of Ground-Water Resources, Routt County, Colorado." All data collected, procedures developed, data analyses, and model development will be reported in this publication.

- D. Distribution of Funds:

Salaries	\$12,180
Travel	2,890
Laboratory Analysis	35,835
Lysimeter Construction	3,695
Observation Well Drilling	5,780
Data Processing	<u>4,620</u>
Total	\$65,000

#### IV. Hydrologic Characterization of North Park

- A. Location: Jackson County, Colorado
- B. Objective: The objective of this program is to define the hydrologic system of the study area, interrelating surface flow, ground-water movement, precipitation, and climate. The availability and quality of surface water will be defined in this study. Ground-water data will be available from the ground-water level monitoring program. This information will be related to present and future mining operations to assess the affects of mining on basin hydrology.

Data collection continued at the five sites in the Coalmont study area. Continuous streamflow records were obtained. Water-quality and sediment samples were collected on a reduced schedule for these sites.

Preliminary reconnaissance for the two sites on the Canadian River was completed in November, at which time monthly discharge measurements were begun as well as collection of monthly samples for water quality and sediment.

Installation of these stations is now being completed. Discharge, water temperature, and specific conductance will be continuously monitored at each station. Monthly water samples will be collected at each station and analyzed for major chemical constituents. Quarterly water samples will be collected at each site and analyzed for trace metals. An automatic sediment sampler will be installed at each station to sample sediment discharge once a day and more frequently during storm events.

C. Report Products: All data will be published annually in "Water Resources Data for Colorado." An interpretive report will be published at the conclusion of the study, three to five years hence.

D. Distribution of Funds:

Salaries	\$18,637
Travel	4,624
Equipment	5,468
Laboratory Analyses	10,115
Data Processing	<u>1,156</u>

Total                      \$40,000

## V. Hydrologic Characterization of Raton Mesa

A. Location: Las Animas County, Colorado

B. Objective: The objective of this program is to define the hydrologic system of the study area, interrelating surface flow, ground-water movement, precipitation, and climate. The availability and quality of surface water will be defined in this study. Ground-water data will be obtained from existing wells. New observation wells from governmental and private drilling programs are being obtained. These ground-water data will be collected and analyzed under Section II. All information will be related to present and future mining operations to assess the affects of mining on basin hydrology. Because of limited funding, only certain major streams within the basins will be monitored during the study.

Five major monitoring locations selected for the two basins include the following general locations: (1) The Purgatoire River near Madrid (expansion of existing streamflow gage), (2) Middle Fork Purgatoire River near Stonewall, (3) the Apishapa River near Aguilar, (4) Sarcillo Canyon near Purgatoire, and (5) Reilly Canyon near Cokedale. Surface-water discharge, chemical quality, and sediment discharge will be collected at each site. The site

on the Purgatoire River near Madrid was selected because it is located downstream of all the major existing and proposed mining operations; the site on the Middle Fork Purgatoire River was selected because it is upstream of all existing and proposed mining operations, and is designed as a baseline station. Sarcillo and Reilly Canyons are two larger drainages into the Purgatoire River and the areas also contain a significant amount of proposed mining. The Apishapa River site was selected to provide a general index of the hydrologic and water-quality characteristics of the basin.

C. Report Products: All data will be published annually in "Water Resources Data for Colorado." An interpretive report will be published at the conclusion of the study, three to five years hence.

D. Distribution of Funds:

Salaries	\$29,365
Travel	2,890
Equipment	8,092
Laboratory Analyses	17,919
Data Processing	<u>1,734</u>
Total	\$60,000

VI. Colorado Salinity Program (YA-350-4340-5225-SS00)

A. Evaluation of Salinity Potential of Mancos Shale Lands:

1. Location: Three study sites: (1) observation reservoir 4-A, Prairie Dog Site; (2) observation reservoir No. 12, Middle Basin Site; (3) observation reservoir No. 2-A, West Twin Site; in Badger Wash near Mack, Colorado.

2. Objectives:

- a. Operate the gages, April 1 - October 31 each year, collect samples, tabulate the streamflow, water quality and rain gage data. The streamflow gages will be operated on a 5-minute punch interval (with peak-stage indicator). The water sampler will be set to collect a sample every 5 minutes during the runoff period. It is estimated that about 10 samples per site be taken after the first runoff event and 3 samples per site for approximately 3 other storms per year will be collected and analyzed.
- b. Run topographic survey of each reservoir at the end of each runoff season.

- c. Equipment purchased to facilitate this contract shall become the property of BLM at the end of the study.

3. Report Products:

- a. Provide BLM with copies of all tabulated data as it is completed. All discharge and water-quality data will be published in "Water Resources Data for Colorado" on an annual basis.
- b. Summarizations will be compiled of total rainfall, runoff, sediment yield, and quality of water carried into the reservoir for each site and submitted to the BLM.

4. Distribution of Funds:

Salaries	\$ 7,281
Travel	656
Vehicles	675
Supplies and Equipment	605
Data Processing	<u>6,783</u>
Total	\$16,000

B. Colorado Water Quality Stations:

- 1. Location: Six gaging stations - 2 on West Salt Creek, 2 on Potter Creek, 1 on West Gypsum Creek, and 1 on Vermillion Creek.
- 2. Objectives:
  - a. Each station would consist of a digital water-level recorder to measure stream stage. A Manning sampler would be installed to obtain water quality and sediment samples. A stage-discharge relationship would be developed for each site from current meter measurements and slope-area measurements. Each station will be inspected weekly with streamflow measurements and water-quality samples obtained at least monthly.
  - b. Equipment will be ordered as soon as this agreement is in effect. Construction of stations would be completed by early spring, 1979. Operation of the gaging stations would be scheduled to continue through the end of FY 79.
- 3. Report Products:
  - a. Provide BLM with copies of all tabulated data as it is completed. All discharge and water quality data will be published in "Water Resources Data for Colorado" on an annual basis.

4. Distribution of Funds: (6 stream flow water quality stations)

Construction and Operation

Construction	\$ 8,835
Surface-water operation	
(assume begin April 1, 1979,	
annual cost \$2,600)	1,300
Water-quality and sediment	
Operation	
(assume begin April 1, 1979,	
annual cost \$3,250)	1,625
Water-quality Laboratory Analysis	<u>700</u>
Total each station	\$12,460
Total six stations	\$74,760

C. Salt and Onion Creek Investigations:

1. Location: Salt Creek (Colorado) which flows out of Sinbad Valley; and Onion Creek (Utah) which flows out of Fisher Valley.
2. Objectives:
  - a. Two gaging stations would be established on Onion Creek and one would be established on Salt Creek to provide data on the quantity of streamflow and the chemical character of the water in these streams.
  - b. A gain-loss seepage study would be conducted along both streams in conjunction with a water-quality sampling and a conductivity survey.
  - c. An evaluation of alternative methods for reducing the high salt loads in these streams would be made for control methods suggested by BLM. Suggested methods include intercepting point sources of saline ground-water discharge which would then be piped upstream and recharged back to the aquifer or disposed of in evaporation ponds. The infiltration rate at potential recharge sites would be investigated using a ring infiltration test. Estimates of long-term recharge rate that could be expected would be made using analytical solutions based on Darcy's equation. Permeability tests would be made on samples of the aquifer to determine the approximate hydraulic conductivity. Saturated thickness of the aquifer and the hydraulic gradient of the ground water would be estimated from geohydrologic considerations. The velocity of the ground water would also be estimated



by Darcy's equation to determine the approximate travel time for ground-water to move from the recharge sites to points of discharge to the stream.

3. Report Products:

- a. Provide BLM with copies of all tabulated data as it is completed. All discharge and water quality data will be published in "Water Resources Data for Colorado" and "Water Resources Data for Utah" on an annual basis.
- b. A detailed final report, showing results and analysis of investigations and technically feasible alternative control procedures, will be published at the completion of the study.
- d. The project would begin on October 1, 1978. Investigations would be completed by September 30, 1979. The results of investigations will be documented in a short report released in one of the GS series (open-file or WRI) publications. Construction of the gaging stations will proceed as soon as possible but would probably not be completed sooner than early spring.

4. Distribution of Funds:

Construction and Operation

3 Streamflow Water-Quality Stations	
(see below for cost details)	\$37,380
Salt Creek Cutoff Wall	2,000

Gain-Loss Seepage Run and Water-Quality Survey

Planning, Data Collection, and	
Analysis of Data	1,710
Quality of Water Laboratory Analysis	650

Evaluation of Salinity Control Methods

Planning, Data Collection, and	
Analysis of Data	6,235
Quality of Water Laboratory Analysis	400

High-Flow Salinity Sampling

Planning, Data Collection, and	
Analysis of Data	4,025
Quality of Water Laboratory Analysis	2,500

Report

Report Writing	3,450
Report Processing and Publication	<u>5,000</u>
Total	\$63,440

D. Colorado River Ground Water Study:

1. Location: Western Colorado
2. Objectives: Continue to gather data on volume of discharge and water quality of ground water entering the Colorado River and its tributaries in Colorado. This data will be used as supporting data to strengthen analyses made in the previous years' study.
3. Report Products:
  - a. Provide BLM with copies of all tabulated data as it is completed. All discharge and water quality data will be published in "Water Resources Data for Colorado" on an annual basis.
  - b. The results of investigations will be documented in a short report released in one of the GS series (open-file or WRI) publications.
4. Distribution of Funds:

Planning, Data Collection, and Tabulation of Results	\$11,400
Laboratory Analysis for Water Quality	<u>5,000</u>
Total	\$16,400

VII. Collection of Climate Data in Western Colorado

- A. Location: North Park and a site near Craig, Colorado.
- B. Objective: The objective of this program is to collect climatic data at two sites which have potential for surface mining for coal.

For FY 79 this program will include the purchase of equipment, installation, and one-half year operation of two climate stations. A station will be placed in North Park and at a site near Craig, Colorado.

C. Report Products: Pertinent data will be published annually in "Water Resources Data for Colorado." All data will be available for use by the Bureau of Land Management. Data from these climate stations near existing USGS/EMRIA study basins may be used in the analysis of the overall hydrology of these study areas.

D. Distribution of Funds:

Equipment	\$23,870
Installation	5,000
Operation and Maintenance	<u>9,130</u>
Total	\$38,000

VIII. Operation of BLM Stations in San Luis Valley (CO-050-4340-5225)

A. Four reservoir inflow sites @ \$1,500

Includes daily flow, crest stage gage, partial flume, digital recorder.

Operation begins January 1, 1979	\$ 6,000
Initial Reservoir Survey	2,200

B. Two reservoir sites, change in contents @ \$1,500

Includes daily change in contents from bubble gage, crest stage gage; once annual survey for sediment.

Operation begins January 1, 1979	\$ 3,000
Initial Reservoir Survey	1,000

C. Six digital recording rain gages @ \$450

One at each site; miscellaneous gages in basin above reservoir.

Operation begins January 1, 1979	\$ 2,700
----------------------------------	----------

D. Two daily stream flow stations to be established later when sites can be selected.

Operation begins April 1, 1979	\$ 2,600
--------------------------------	----------

Total	<u>\$17,500</u>
-------	-----------------



**Montana**



## MONTANA

### I. Hydrologic Characterization of Southeastern Montana Coal Areas

A. Maintain network of stream-discharge and water-quality monitoring sites.

1. Objectives: Collect streamflow and water quality-data at key locations to supplement other programs. The data is essential in defining runoff from potential impact areas, determining streamflow characteristics, and providing a data base from which future changes can be analyzed.
2. Procedure: Standard U.S. Geological Survey methods of surface-water and quality-water data collection will be used to obtain data at the following stations:

East Fork Trail Creek (2 stations)  
Beaver Creek at Wibaux  
Home Creek near Ashland  
Nelson Creek near Van Norman  
Prairie Elk Creek near Oswego  
Burns Creek near Savage  
Pumpkin Creek near Miles City  
Mizpah Creek near Olive  
East Fork Trail Creek  
Tongue River below Brandenburg Bridge near Ashland  
Timber Creek near Van Norman  
Horse Creek near Circle  
Spring Creek near Decker  
Hanging Woman Creek below Horse Creek  
Prairie Dog Creek near Birney  
Pumpkin Creek near Sonnette  
Snyder Creek near Brandenburg  
Otter Creek near Otter  
Glendive Creek near Glendive  
Cherry Creek near Terry  
Cottonwood Creek near Glendive  
Otter Creek below Fifteen Mile Creek  
Musselshell River near Roundup  
Half Breed Creek near Klein  
Rehder Creek near Klein  
Fattig Creek near Delphia  
East Parrot Creek near Roundup  
West Parrot Creek near Roundup  
Tongue River below Tongue River Dam  
East Fork Armells Creek near Colstrip  
Armells Creek near Forsyth  
Rosebud Creek at Kirby  
Rosebud Creek near Colstrip  
Rosebud Creek at Mouth

3. Report Products: Basic records from streamflow and surface-water-quality sites will be submitted to BLM annually or as mutually agreed upon. Records will be published by the USGS in an annual basic data report, "Water Resources Data for Montana." The data will be used by the USGS in preparing interpretive reports described in other parts of the work plan.
4. Relationship to Other USGS Studies: This program will supplement and be correlated with other USGS programs of streamflow and surface-water-quality data collection. Other stations operated in this area include:

Redwater River at Circle  
O'Fallon Creek near Ismay  
Upper Seven-Mile Creek near Glendive  
Custer Creek near Kinsey  
Crow Rock Creek near Rock Springs  
Deer Creek near Glendive  
Muster Creek near Kinsey  
Clear Creek near Hoyt  
Redwater Creek near Vida  
Mizpah Creek near Mizpah  
Nelson Creek near Van Norman  
Prairie Elk Creek near Oswego  
Squirrel Creek near Decker  
Burns Creek near Savage  
Half Breed Creek near Roundup  
Sarpy Creek near Hysham  
Hanging Woman Creek near Birney  
Otter Creek at Ashland

5. Distribution of Funds:

Salaries	\$61,640
Lab Services	32,270
Travel	39,806
Supplies	4,345
Data Processing	9,630
Total	\$147,700

B. Sediment Data Collection.

1. Objectives: Collect sediment data downstream from areas where problems may be encountered from lease areas. The data is essential in defining present sediment loads from which future changes can be analyzed.

2. Procedures: Suspended sediment samples will be collected and analyzed using standard USGS methods at the following streamflow monitoring sites:

Tongue River below Brandenburg Bridge near Ashland

3. Report Products: Basic records will be submitted to BLM annually or as mutually agreed upon. Records will be published by the USGS in an annual basic data report, "Water Resources Data for Montana."
4. Relationship to Other USGS Studies: This program will supplement and be correlated with other USGS sediment data collection programs. The USGS operates sediment stations at the following sites:

Yellowstone River at Billings  
Yellowstone River at Forsyth  
Tongue River at Miles City

5. Distribution of Funds:

Salaries	\$ 4,735
Travel	2,939
Laboratory Services	2,566
Data Processing	<u>280</u>
Total	\$10,500

## II. Hydrologic Modeling

- A. Location: Prairie Dog Creek watershed in southeastern Rosebud County has been selected as the study site.
- B. Objectives: The USGS has developed rainfall-runoff models which accurately predict runoff from storm events in some environments. However, the models have been developed for use in geologic and climatic conditions quite different from the prairie environment of Montana's coal region. The USGS is attempting to modify existing models to be responsive to the climatic and geologic conditions which prevail in eastern Montana. The Montana District, in conjunction with other WRD districts and Regional research hydrologists will pursue problems related to runoff from snowmelt and for rainfall on frozen ground and other situations more appropriate to the northern plains region. Hopefully the modified model can be calibrated for the Prairie Dog Creek watershed to verify its suitability for this area. If successful, the model will be extremely useful in evaluating the effects of land-use changes such as strip mining or reclamation on run-off from small drainages.

- C. Procedures: The Prairie Dog Creek watershed will be instrumented with climatological and soil-moisture monitoring equipment to determine various parameters for modeling. Precipitation gages will be installed, soil-moisture access tubes will be emplaced, soil-temperature probes will be planted, stream gaging stations will be constructed, and monitoring of various parameters will begin. After data collection has begun, the hydrologic modeling will begin. Test runs to evaluate various components of the model will indicate where refinements are needed.
- D. Report Plans: Data collected as part of this study will be extremely valuable to researchers in other agencies and to universities. To make this data useful to others, a series of basic data reports is planned to release climatological, soil, and streamflow data. Progress reports describing activities and work accomplished are planned for open-file release. A final report describing the research and results is planned in cooperation with other WRD districts. The final report will probably be published in the Professional Paper series to allow wide distribution.
- E. Relationship to Other USGS Studies: This project compliments other programs in the Montana District. One currently troublesome aspect of rainfall-runoff modeling, for example, is the relationship of streamflow to ground-water systems. Work on the ground-water aspects of the study area being funded under another project will be extremely useful in evaluating the relationship of infiltration and ground-water discharge to streamflow. Several other WRD districts are involved in modifying existing runoff models to simulate various climatic, geographic, and geologic settings. Montana's work will be closely coordinated with these districts to minimize duplication, exchange information, and share experience and equipment.
- F. Distribution of Funds:

Salaries	\$ 9,699
Travel	15,515
Computer Costs	7,272
Installation of Power Line	12,121
Equipment	12,121
Data Processing	8,424
Report Preparation	<u>4,848</u>
Total	\$70,000

### III. Ground-Water Monitoring

- A. Location: Fort Union Coal Region of eastern Montana.

- B. Objectives: To provide ground-water data base from which an assessment can be made of the resource, future responses to stresses can be predicted, and pollution and supply problems can be detected and defined. This activity provides for long-term collection of ground-water data from selected observation wells. Specifically, wells monitored in EMRIA study sites are incorporated in this program to extend periods of data collection.
- C. Procedures:
1. Make water-level measurements and continue operation of water-level recorders.
  2. Compile and analyze data.
  3. Collect ground-water samples from selected wells.
  4. Analyze water samples.
- D. Report Products: Data collected under this program will be incorporated in EMRIA Site Study reports and in regional evaluations. The data will be stored in automated data files for rapid retrieval.
- E. Relationship to Other USGS Studies: Data collected under this activity will be used to help define pre-mining conditions of reclamation study sites, help calibrate ground-water models to predict the effects of mining, and help transfer data to surrounding areas from intensively studied reclamation sites.
- F. Distribution of Funds:

Salaries for Data Collection	\$18,190
Laboratory Services	7,255
Travel	4,836
Data Processing	7,255
Data Compilation and Analysis	<u>8,464</u>
Total	\$46,000

#### IV. Construction of Observation Wells

- A. Location: Fort Union Coal Region in eastern Montana.
- B. Objectives: To extend the ground-water data base from which an assessment can be made of the resources, response to future stresses can be predicted, and pollution and supply problems can be detected and defined. To provide the ground-water data necessary to extend in space the results of reclamation studies and to relate site studies to regional studies.



C. Procedures:

1. Case, complete, and evaluate test holes drilled for coal exploration by other agencies as observation wells and/or sites to obtain aquifer coefficients.
2. Collect water samples shortly after drilling and testing.
3. Analyze water samples for selected parameters.
4. Enter test holes into existing monitoring program.
5. Cooperate with BLM offices to insure data is obtained in critical areas and that data collected by other public and private organizations is checked for quality.
6. Coordinate with Montana Bureau of Mines and Geology to insure adequacy of test drilling projects.

D. Report Products: Data from this activity will be included in open-file reports, EMRIA Site Study reports, and other publications. Data will be stored in automated files for release upon request.

E. Relationship to Other Studies: Test hole data collected under this program constitutes a link between site-specific studies and the studies necessary to describe and predict the regional effects of coal extraction on the ground-water resources.

F. Distribution of Funds:

Laboratory Services	\$ 2,447
Rig Time for Testing and Installing Casing	3,627
Purchase of Casing	3,627
Salaries for Field Operations	4,836
Salaries for Coordination Efforts	2,660
Travel	4,594
Data Processing	<u>1,209</u>
Total	\$23,000

V. EMRIA Site Studies

- A. Locations: During FY 79, the EMRIA sites to be studied include Prairie Dog Creek, Ashland, and West Otter Creek. Preliminary work will be started on the Sweeney-Snyder and Corral Creek sites.
- B. Objectives: To collect and evaluate hydrologic data at EMRIA sites for appraisal of reclamation potential. The studies are designed to compile available hydrologic information, design and implement data collection programs, coordinate data collection



activities with other agencies and private companies, and to evaluate the potential hydrologic impacts of mining and reclamation.

- C. Procedure: Available hydrologic data for each site will be compiled and evaluated. Where data gaps exist, programs will be planned to provide necessary information. Test drilling programs will be designed in areas where additional geologic and hydrologic control is needed. Monitoring programs will be initiated to monitor water quality and water-level fluctuations.
- D. Report Products: Information from this program will be prepared for inclusion in BLM-EMRIA reports. If formal EMRIA reports are not prepared, water resources investigation reports summarizing the findings of the studies will be prepared for release. The reports will be designed for inclusion in Environmental Assessment Reports.
- E. Distribution of Funds:

Salaries for Data Collection	\$ 60,608
Travel	16,969
Laboratory Services	2,424
Data Processing	12,121
Data Interpretation and Reduction	<u>27,878</u>
Total	\$120,000

## VI. Evaluation of Surface-Water Quality Data

- A. Location: Fort Union Coal Region of eastern Montana
- B. Objectives: Numerous water-quality stations have been operated throughout the Fort Union coal region to obtain basic data needed to evaluate the impacts of mining and the potential for reclamation. Analysis of the data is needed to define geochemical processes, determine relationships, and evaluate the necessity of modifying the network. In addition, modeling techniques should be applied to evaluate regional relationships between water quality and land use, geology, and runoff.
- C. Procedures: Statistical methods will be used to evaluate the surface water quality data. Regression techniques will be applied to determine station correlations. Data collected from existing stations will be evaluated to determine the desirability of continuing, modifying, eliminating, or replacing stations to insure that monitoring sites provide the necessary information. Regional analysis and modeling techniques will be applied to define cause-effect relationships between water quality and basin characteristics. An analysis of the suitability of organic carbon monitoring for detecting changes due to mining will be included.

- D. Report Products: The results of this investigation will be used to modify the existing surface water quality monitoring network in the Fort Union coal region. A report summarizing the statistical correlations and regression analyses will be published in the Water Resources Investigations series.
- E. Relationship to Other USGS Studies: This activity extends the surface-water quality monitoring program to include reduction, analysis, and interpretation of data. In raw form, data from the monitoring program is of limited usefulness. By reducing the data to an easily understood form, analysis and interpretation is possible. Thus this project greatly increases the usefulness of data collected under other programs. Results of this activity insures collection of meaningful information.
- F. Distribution of Funds:

Salaries	\$33,941
Laboratory Services	2,424
Computer Costs	8,121
Travel	3,030
Report Preparation	<u>8,484</u>
Total	\$56,000

## VII. Well Inventory Contract

- A. Location: Fort Union Coal Region north of Yellowstone River
- B. Objectives: To provide ground-water data in lower priority lease areas north of the Yellowstone River. Little work has been done in potential coal lease areas in the Big Dry Creek area north of the Yellowstone River. Before detailed evaluations of reclamation potential can be made, existing wells must be inventoried. By contracting well inventories prior to beginning reclamation studies, considerable time can be saved.
- C. Procedures: An area where ground-water data is sparse will be selected for inventory. A well inventory contract specifying density of inventory and area of coverage will be let. In addition to collecting basic information on wells, the contractor will be required to measure depths to water and collect water samples for chemical analysis.
- D. Report Products: Data collected under this activity will be utilized in future reclamation studies. The data will be entered into automated files for future access.

E. Relationship to Other USGS Studies: The USGS is attempting to develop a data base throughout the Fort Union Coal Region from which future impacts can be gaged, reclamation potential can be evaluated.

F. Distribution of Funds:

Contract	\$34,688
Laboratory Services	<u>2,312</u>
Total	\$37,000

VIII. Grants

A. Grant to Montana Bureau of Mines and Geology for Test Drilling and Aquifer Testing in High Priority Lease Areas.

1. Location: Fort Union Coal Region in vicinity of Ashland, West Otter Creek, Corral, and Sweeney-Snyder coal lease areas.
2. Objectives: To drill test holes, install casing, conduct aquifer tests, and monitor water levels at selected sites in high priority lease areas. This grant provides for collection of ground-water data in areas where data are needed to evaluate effects of mining and potential for reclamation.
3. Procedures: After an initial evaluation of existing data, locations where additional information is needed will be selected. The Montana Bureau of Mines and Geology will drill test holes at the selected sites, install casing, conduct aquifer tests, collect water samples, and monitor water levels.
4. Report Products: Field data will be compiled in a report describing the results of drilling and testing. Montana Bureau of Mines and Geology will submit the report to USGS for distribution to BLM.
5. Relationship to Other USGS Studies: The grant provides basic geologic and hydrologic data needed for completion of EMRIA site studies. Without the information from this program, definition of the ground-water systems would be difficult.
6. Distribution of Funds:

Grant to Montana Bureau of Mines and Geology	\$90,000
---	----------

B. Grant to Montana Department of Health and Environmental Sciences to Complete Benthic Study of Streams Draining Coal Fields in the Fort Union Coal Region.

1. Location: Fort Union Coal Region of southeastern Montana.
2. Objectives: The objectives of this grant are to obtain biological data on periphytic and macroinvertebrate components of stream benthos at selected sites in the southern part of the Fort Union coal region and assess the effects of salinity on stream biota. The study hopefully can provide information on potential effects of increased salinity resulting from mining activities on stream biota.
3. Procedures: Biological sampling will be directed to perennial or near perennial stream now being monitored by the USGS for water quality information. Intensive biological sampling will be done on two to four streams at four to six locations for two years. Seasonal sampling will also be done at ten to fourteen sites. The effects of salinity on the biota will be evaluated. The project was initiated in FY 78. This phase will complete the work.
4. Report Plans: The grantee will provide interim reports on the study and a final report at the completion of the two-year investigation.
5. Relationship to Other USGS Studies: The USGS is collecting considerable information on quality of water in streams in the Fort Union coal region. Relating this data to biological productivity is important in evaluating potential environmental impacts of mining activities.
6. Distribution of Funds:

Grant to Montana Department of  
Health and Environmental Sciences          \$26,000

C. Grant to Montana State University - Sulfur Cycle Study

1. Location: Fort Union Coal Region of southeastern Montana.
2. Objectives: Sulfate concentrations in ground water in the Fort Union Coal Region are relatively high. Sulfate reduction has been observed but the mechanisms are poorly understood. The purpose of this study is to determine what role bacteria play in the sulfur cycle.

3. Procedure: Isotope fractionation techniques will be used to determine whether sulfide in ground water is bacterially produced. Ground-water samples will be analyzed to determine if sulfate-producing bacteria are present. Rates of dissimilatory sulfate reduction will be measured in the laboratory using sensitive isotopic methods. The first phase of the project is currently underway. During FY 79, the areal coverage will be expanded to cover large areas of the Fort Union coal region.
4. Report Plans: The grantee will provide a final report to the USGS upon completion of the project.
5. Relationship to Other USGS Studies: The USGS is actively engaged in geochemical studies in the Fort Union Coal Region as a tool for understanding the ground-water flow systems. An important aspect of the ground-water quality is the mechanism of the poorly understood sulfur cycle. This research will provide valuable information regarding this complex problem and will aid in interpreting the overall geochemical processes associated with mining activities.
6. Distribution of Funds:

Grant to Montana State University                      \$17,000

IX. Other Studies (MT-930-4340-5273)

A. Big Sheep Creek Surface Water Station #06013500

1. Data Collection: Continuation of an established station.
  - a. Continuous flow measurement.
  - b. Four months daily suspended sediment data collection.

B. Reservoir Survey

1. Location: Phillips County Resource Area, the following reservoirs:

<u>GS #</u>	<u>Reservoir Name</u>	<u>Location</u>
14	PR-22	T36N, R30E, Section 13
15	Alternate	T37N, R32E, Section 29
16	Whitewater Lake (North)	T36N, R31E, Section 35
17	Whitewater Lake (South)	T35N, R31E, Section 1
18	Cool Pit	T35N, R31E, Section 24
19	King	T24N, R30E, Section 15
20	PR-18	T25N, R30E, Section 5



21	Parrot Flats	T26N, R27E, Section 16
22	PR-71	T29N, R28E, Section 22
23	Bennett Lake	T28N, R30E, Section 1
24	Empire	T28N, R29E, Section 22

2. Purpose: To undertake a limnological reconnaissance of the above lakes and reservoirs in Phillips County, Montana. This study is to provide water-quality data that would help determine the types of uses suitable for several small reservoirs in the Phillips County area. Reservoir uses under consideration by the (BLM):
  - a. Livestock watering.
  - b. Waterfowl production.
  - c. Fish propagation, and
  - d. Body contact recreation.
3. Approach: Eleven reservoirs in the Phillips Resource Area will be sampled in FY 79. The following sampling periods were chosen to study each reservoir when limnological conditions are most critical to the proposed reservoir uses:
  - a. Late winter, when ice cover prevents exchange of gases with the atmosphere.
  - b. Early spring, when ice cover is gone, the reservoirs are completely mixed, and peak inflow has occurred.
  - c. Late summer, when there is a possibility of stratification of the reservoir water and development of anoxic conditions in the hypolimnion.
  - d. After all mixing when any stratification has been disrupted and hypolimnion water is mixed throughout the lake, possibly causing less desirable habitat for biota.

Measurements of light penetration will be made at each reservoir during each visit as an indication of the relative amount of suspended material in each reservoir. Depth profiles of each reservoir will be made for temperature, dissolved oxygen, specific conductance, and pH.

To further characterize each reservoir, the concentrations of selected chemical constituents will be determined. Chemical analyses will include: (1) major dissolved constituents -- calcium, magnesium, potassium, sodium,

bicarbonate, chloride, fluoride, silica, and sulfate;  
(2) trace elements (dissolved) of primary concern in the area -- boron, copper, iron, lead, manganese, and zinc;  
(3) trace elements of secondary concern -- arsenic, barium, cadmium, chromium, cobalt, mercury, nickel, selenium, silver, and vanadium; and (4) plant nutrients -- dissolved ortho phosphate, dissolved phosphorus, total phosphorus, dissolved organic carbon and suspended organic carbon.

Phytoplankton, benthic invertebrate, and bacterial samples will be collected and analyzed from each reservoir to reflect the quality of life each reservoir is supporting.

Field measurements for dissolved oxygen, temperature, specific conductance, and pH will be made at one meter intervals using a Martek water-quality instrument near the outlet or middle of each reservoir (the deepest site). Light penetration at each sampling site will be measured using an 8-inch (20 cm) diameter Sacchi Disk.

Water samples for chemical analysis will be collected near the bottom and surface of each reservoir site using a Kemmerer water sampler. The samples will be field treated for preservation. Field parameters will be determined at the site and laboratory samples will be analyzed at an accredited laboratory.

Phytoplankton will be collected from each reservoir using a plankton net with a .202 mm mesh opening. Samples will be collected by towing the plankton net vertically the full depth of water at each site. Benthic invertebrate samples will be collected with an Ekman grab at three locations near the outlet of each reservoir. Phytoplankton and benthic invertebrates will be analyzed at a private laboratory. Procedures for the preservation and analysis (identification and enumeration) of phytoplankton and benthic invertebrates will follow methods described by Slack and others (1973).

Total coliform, fecal coliform, and fecal streptococcus bacteria will be collected from grab samples of water at each chemical sampling site and near the shore of easiest access to each reservoir. Field analysis of bacterial samples will follow techniques described by Slack and others (1973).

Field work for the proposed study of reservoirs in Phillips County area will begin the winter of FY 79. Samples will be collected by personnel from the USGS Fort Peck Field Office with assistance from district office personnel. The project chief will devote about six man weeks of effort during FY 79 and about 1/3 man year in FY 80. He will be supported by field personnel from the Fort Peck field office and the district office.



4. Reports: The final report covering the reservoirs sampled in Valley County in FY 78 will be available for review in early FY 79 and in final form before the end of FY 79.

The final report covering the reservoir sampling described herein will be available for review in early FY 80 and in final form before the end of FY 80.

5. Distribution of Funds:

Salary	
Data Collection	\$ 4,880
Data Analysis	2,075
Lab Charges	10,100
Travel	3,365
Stream Gage	7,010
Space Rental	1,020
District Support	<u>3,800</u>
Total	\$32,250

**New Mexico**



## NEW MEXICO

### I. Hydrologic Modeling

- A. Location: The small watershed control basin with drainage area of 8.2 square miles is located within and around BLM's Kimbeto reclamation study area in northwestern New Mexico.
- B. Objectives: The objectives are to develop, test, and verify precipitation-runoff models for predicting surface runoff characteristics and sediment yield under various land-use conditions in the coal-lease areas in northwestern New Mexico. The emphasis will be on relating parameters used by the model to measurable physical features of a selected watershed basin to facilitate transferability of the model from an instrumented basin to uninstrumented basins.
- C. Procedure: A watershed basin with a drainage area of 8.2 square miles in the strippable coal-lease area in the San Juan Basin is instrumented to collect data for the development, testing, and verification of the precipitation-runoff model. The instrumentation includes a streamflow gaging station, a PS-69 automatic pump sampler, and array of nine single-stage samplers to statistically evaluate the water samples collected outflowing from the basin; a meteorological station for continuous monitoring of relative humidity, air temperature, wind speed, wind direction, and solar radiation in the basin; and five recording raingages spaced for equal areal distribution over the basin. Data for model development will also be collected and analyzed to define the basin soil-moisture storage characteristics, infiltration characteristics, soil detachability, vegetation characteristics, and topography. A field-portable rainfall simulator will be used to define infiltration rates, overland flow, and sediment yields from various combinations to topography, soils, vegetation, and land use on the basin. The rainfall-simulator runs will also be made on active and reclaimed mine spoils near the selected study basin. 10

In addition to the raingages at the study basin, three recording raingages will be operated in the strippable coal-lease area of northwestern New Mexico. The rainfall data from these raingages and the raingages at the study basin will be synthesized with a stochastic model to generate long-term rainfall data which will be the driving variable for the precipitation runoff model. The only long-term continuous-recording precipitation station available near the strippable coal-lease area in northwestern New Mexico is the National Weather Service station at Farmington. 3'

Data will be tested in the basin model developed by the Regional Precipitation-Runoff Modeling Group as it is being collected. Data testing during the collection period will aid in refinement of data collection techniques.

D. Report Products: An interim report will be prepared in about 1881, at which time it is estimated enough data will be available for an initial calibration of the model. As additional data are collected and the model is improved and verified, the report will be updated. This effort is closely coordinated with the efforts of the research group in the Central Regional Office.

E. Distribution of Funds:

Salaries	\$26,585
Travel	5,780
Supplies and Equipment	5,545
Laboratory Analyses	5,780
Data Processing	<u>2,312</u>
Total	\$46,000

II. Watershed Characterization

A. Location: Coal-lease areas of northwestern New Mexico.

B. Objectives: To provide BLM with a method to estimate quantity and quality of runoff from small ungaged watersheds.

C. Procedure: The data to develop a relation to estimate streamflow and water-quality characteristics from watershed parameters in the coal-lease areas, that can be measured or identified were collected during the 1978 fiscal year. The data collected for each of 20 small watersheds most of which have short periods of streamflow and water quality records includes channel-geometry measurements, streambed material particle size distribution, channel slope, infiltration rate of watershed and vegetative cover. Other data compiled for each of the watersheds includes drainage area, mean-annual precipitation, watershed slope, and basin shape. Collection of water-quality information on reclaimed spoil piles will be continued as part of this effort.

Regression techniques will be used to develop methods for predicting streamflow and water-quality characteristics from channel geometry and watershed characteristics.

This study will be closely coordinated with a regional watershed characterization study of strippable coal areas in the central and western United States. The objectives of the regional study are: (1) to test the transferability of existing streamflow-basin characteristics relationships to coal lease areas; (2) to develop new relationships for streamflow characteristics to measureable dimensions of channel geometry and basin characteristics for ephemeral streams; and (3) to develop similar relationships for estimating sediment transport characteristics and other water quality transport characteristics for perennial and ephemeral streams.

D. Report Products: An administrative report defining the significant relations for predicting streamflow and water quality characteristics found by regression analyses will be prepared during FY 79. This report will be considered an interim report since the relations will be based on short periods of streamflow records. The plan is to update this interim report in the future based on longer periods of records or when additional relations are developed.

E. Distribution of Funds:

Salaries	\$16,436
Travel	4,124
Data Processing	<u>3,440</u>
Total	\$24,000

III. Hydrologic Surveillance of Coal-Lease Areas

A. Location: Areas of study are located in coal-lease areas of San Juan and McKinley Counties located in northwestern New Mexico.

B. Objectives: (1) Document hydrologic characteristics of streamflow and ground water in coal-lease areas and their variabilities in quantity and quality; (2) predict the effects of coal extraction and associated development on the water resources in northwestern New Mexico; (3) provide BLM's office and field staffs with timely, short, interpretative reports. This information will aid the Bureau of Land Management in their operations pertaining to coal-lease stipulations and land management practices of multiple purpose uses of the public domain.

C. Procedure: We will continue to operate and maintain established basic data collection sites in order to collect adequate water resources data under natural or present conditions to establish a baseline as to quantity and quality from which to predict the effects of surface extraction of coal and related activities. Some of the areas at or near the gaged sites will be mined in the future which will enable us to compare the measured effects of surface mining for coal on the water resources to the predicted effects.

5  
1. Surface Water: The established surface flow data collection sites to be operated during FY 79 includes five streamflow sites for quantity and quality of water. All streamflow gaging sites have a set of three or four single-stage samplers for collecting water quality samples at different flow stages.

Two sites have three single-stage samplers collecting replicate samples at each of three stages (nine single-stage samplers per site). The replicate samples will be evaluated statistically to determine the reliability of individual



samples collected with single-stage samplers modified by the New Mexico District for sampling ephemeral streams containing very high suspended sediment concentrations.

2 The established surface water collection sites also include eight partial record sites for collection of samples inflowing into study areas from the main arroyo or side washes. Two of these partial record sites are equipped with peak stage gages.

We will continue to collect a comprehensive suite of water quality parameters at least once annually at ephemeral flow sites and twice annually at perennial flow sites. The comprehensive suite of parameters would include major inorganic constituents, trace elements, nutrients including organic carbon, radio chemical parameters, and suspended sediment data. At perennial sites biological data also will be collected. Water quality parameters such as specific conductance, pH, suspended sediment concentration and organic carbon will be measured on additional samples because of their usefulness as index water-quality parameters. Other parameters such as arsenic, selenium, mercury, boron and lead also will be measured more frequently because of their association with coal. Other constituents found in unusually high concentrations will also be analyzed more frequently. We will attempt to analyze a minimum of six samples for partial chemical analyses from each site annually and to sample as many flow events as possible at a site. Samples will be collected by field personnel if the site is found flowing, or samples will be collected by single-stage samplers, or by the automatic pump samplers.

2. Ground Water: The established ground-water data collection sites consist of 25 wells that are completed either in the coal seam, in the underlying Pictured Cliffs Formation, or in the coal overburden. We will measure water levels in these wells at least twice annually and collect samples from each of these wells for complete chemical analysis at least once annually. After collection of sufficient samples over several years to define the water quality in these wells, the annual sampling frequency will be reduced at a well if no water quality changes are found in that well.

- D. Report Products: All data collected in the BLM-EMRIA program will be published by the USGS in the annual basic data report, "Water Resources Data for New Mexico." Water resources information that have been collected in the BLM-EMRIA program and other programs in the strippable coal areas will be analyzed to aid BLM in management decisions of coal-lease areas of the public domain in the interim prior to the release of comprehensive formal reports such as water supply papers. Preliminary information on transfer



techniques and interpretations of flow systems other than those of these studies. The subject of these studies will be determined through close collaboration with BLM personnel. Proposed reports are:

1. The distribution of trace elements, nutrients, and organic carbon in the coal related ground-water and surface-water systems of northwestern New Mexico. FY 79.
2. Correlations between chemical constituents, suspended sediment and water discharge in the arroyos and river of northwestern New Mexico. FY 79.
3. Water bearing characteristics of the overburden, coal, and underlying sandstone-shale of the Fruitland strippable coal trend in northwestern New Mexico. FY 79.
4. Thickness, water bearing characteristics, and chemical quality of water in the valley fill of the Chaco River in northwestern New Mexico. FY 80.

E. Distribution of Funds:

Salaries	\$75,205
Travel	13,872
Supplies and Equipment	8,554
Laboratory Analyses	28,901
Data Processing	<u>3,468</u>
Total	\$130,000

# NEW MEXICO

## LIST OF WATER QUALITY PARAMETERS\*

The water quality parameters that may be measured are shown on the attached list. The project investigator shall select from this list the parameters to be measured for a sample and the frequency of measurement at a site. The data will be reviewed as the analyses are completed. Other parameters may be added to this list if needed. The dissolved and suspended concentrations of many constituents, particularly trace elements, will be determined. The schedules shown below will be followed as closely as possible with consideration given to available sample, sampling time, sampling stage, unusual concentrations and any other sampling contingencies.

Parameter	Annual for Ephemeral streams	Semi-Annual for Perennial streams	Six samples minimum annual for Ephemeral or Perennial streams	Annual for GW sites
Alkalinity			X	X
Arsenic			X	X
Barium	X	X		X
Bicarbonate			X	X
Boron			X	X
Cadmium	X	X		X
Calcium			X	X
Carbon, organic			X	X
Carbonate			X	X
Chemical oxygen demand	X	X		X
Chloride			X	X
Chromium	X	X		X
Coliform bacteria, fecal		X		
Discharge at sample time			X	
Fluoride			X	X
Hardness			X	X
Hydroxide (pH dependent)			X	X
Iron			X	X
Lead			X	X
Lithium	X	X		
Magnesium			X	X
Manganese	X	X		X
Mercury			X	X
Molybdenum	X	X		X
Nitrogen, ammonia	X	X		X

Parameter	Annual for Ephemeral streams	Semi-Annual for Perennial streams	Six samples minimum annual for Ephemeral or Perennial streams	Annual for GW sites
Nitrogen, nitrate			X	X
Nitrogen, nitrite	X	X		X
Oxygen, dissolved			X (perennial)	
pH			X	X
Phosphorous			X	X
(as dissolved PO <sub>4</sub> )				
Phosphorous (total)	X	X		X
Potassium			X	X
Phytoplankton		X		
Radioactivity, gross alpha	X	X		X
Radioactivity, gross beta	X	X		X
Radium	X	X		X
Residue at 180° C	X	X		X
(dissolved solids)				
Selenium			X	X
Silica			X	X
Sodium			X	X
Specific conductance			X	X
Streptococci bacteria, fecal		X		
Strontium	X	X		X
Sulfate			X	X
Sulfide				X
Suspended sediment			X	
(total)				
Suspended sediment	X	X		
(particle size)				
Temperature, water			X	X
Uranium	X	X		
Vanadium	X	X		

\* Parameters, dropped from the original list because they are considered not important in the coal lease areas of New Mexico at this time are acidity, alumium, beryllium, cobalt, color, copper, cyanide, nickel, silver, turbidity, and zinc.



**North Dakota**



## NORTH DAKOTA

### I. Hydrologic Modeling

#### A. Beulah Trench

1. Objectives: Preliminary data indicate that the proposed expansion of strip-mining activities in the Beulah Trench area, North Dakota, may result in changes in the streamflow, geochemical, and ground-water regimen. Some changes will be temporary but others may remain even after strip mining has ceased. The purpose of this investigation is to (1) determine premining hydrologic and geochemical conditions in a small representative drainage basin, (2) provide historical data with which to compare the magnitude of change with mining, and (3) determine the hydrologic and geochemical effects of mining in nearby areas on the Antelope Creek aquifer.

In order to understand the operation of the existing hydrologic and geochemical systems in the Beulah Trench area and predict the effects of new stresses imposed on it by mining operations, it will be necessary to simulate the system by means of a digital model or models involving finite element and difference approximations of the ground-water and surface-water flow and mass transport equations. Although either electric analog or digital model could be used, the digital model is preferable because of time, cost, and facility restrictions. A three-phased approach to quantitative hydrology in the study area is planned.

#### a. Phase I: (Completed in FY 78)

- (1) Collation and evaluation of existing hydrologic and chemical data used as the resource base.
- (2) Development of conceptual models of the hydrologic and geochemical system and selection of digital computer models that simulate the hydrologic conceptual models.
- (3) Selection and installation of the final test holes, observation wells, and other data acquisition sites.
- (4) Adjustment and refinement of the conceptual models.

#### b. Phase II: (Partially completed in FY 78)

- (1) Collection of new geologic, hydrologic, and chemical data.



- (2) Refinement of data for the digital models and evaluation of results. Adjustment and calibration of digital models as necessary.
- (3) Digital models representing the hydrologic system are available.
- (4) The geochemistry may not lend itself to digital modeling, but other methods of analyses are being used.
- (5) A preliminary hydrology report for the area will be supplied to Bureau of Reclamation for inclusion in the EMRIA report of 1978.

c. Phase III:

- (1) Based on the conceptual and digital models developed, the effects of mining on various phases of the hydrologic and geochemical systems will be forecast.
- (2) It is the US Geological Survey's intention to continue the collection of surface-water and related records for a few years (estimated at 5) to define the hydrology of a pilot watershed within the EMRIA basin (proposed for EMRIA funding).
- (3) A final report on the overall EMRIA area of study is planned for September 30, 1979.

2. Relationship to Other Closely Associated Non-EMRIA Funded Activities:

The Beulah Trench lignite deposit is one of the deposits that will be covered by the hydrologic reconnaissance studies under ND-070F, which was started in FY 75 and is funded by the US Geological Survey. The data collection under ND-070F will be of value to the present study. Inasmuch as the ultimate objective of ND-070F is to provide an in-depth appraisal of the hydrologic effects of mining for each of the identified strippable deposits, the Beulah Trench study will result in a savings in the eventual overall cost of ND-070F.

Data on streamflow, sediment loads, quality of water, and ground-water levels are being collected in the vicinity of the study. These data are being collected through programs with the North Dakota State Water Commission, the Environmental Protection Agency, and Corps of Engineers, and the U.S. Geological Survey funds. There will be a mutually beneficial exchange of data between the programs.

3. Distribution of Funds:

Salaries	\$49,413
Travel	7,951
Supplies and Equipment and Laboratory Costs	6,506
Data Processing, including Computer Costs	<u>2,530</u>
Total	\$66,400

B. Wibaux-Beach

1. Objectives: The strippable lignite of the Wibaux-Beach deposit is a major aquifer of the area and is in close stratigraphic association with the other aquifers. The deposit area is probably within a region of major recharge to the lower Tongue River and Ludlow aquifers. The probable hydrologic impacts of coal development on these aquifers are not known. Most streams within the study are ephemeral, but one does flow for most of the year and is the source of irrigation water for several adjacent landowners. Mining activities may impact the surface waters in terms of both quantity and quality of streamflow. Also of concern are the geochemical modifications attendant the mining process and the effects these altercations may impose on the hydrologic system.

The objectives of this investigation are to (1) define the premining hydrology and geochemical regime within the drainage basins containing the Wibaux-Beach lignite deposit; in so doing, a historical data base will be established with which to assess any modifications attendant on future coal mining; and (2) develop the capability of projecting the hydrologic ramifications of various land treatments imposed by the mining process.

Strip mining disrupts the zone of interaction between the atmospheric, terrestrial, and subterranean segments of the hydrologic cycle. Programs and instrumentation necessary to determine the flow and quality characteristics and the various modes of exchange of water between the respective segments will be initiated early in the project. The data collected will be used in conjunction with digital models to gain a thorough knowlege of the hydrologic regime. Quantitative hydrologic parameters will be refined and data deficiencies will be identified with the aid of the models. When the models are calibrated and verified against the present hydrologic system, they will be available for estimating the hydrologic ramifications of various land treatments within the study area. A final complete report is planned for April 1980.

2. Relationship to Other Closely Associated Non-EMRIA Funded Activities:

The study proposed herein will be funded jointly through EMRIA funds and US Geological Survey Federal funds. The Wibaux-Beach lignite deposit is one of the deposits covered by the hydrologic reconnaissance studies under ND-070F, which was started in FY 75, is scheduled for completion in FY 77, and is funded by the US Geological Survey. The portion of the deposit in Golden Valley County is covered by the County Water Resources Study under ND-069, which was started in 75 and scheduled for completion in 78. This study is funded under a cooperative agreement by the US Geological Survey, North Dakota State Water Commission, US Park Service, and US Forest Service. These studies though at a reconnaissance level, result in substantial savings in the present study.

Data on streamflow, sediment loads, quality of water, and ground-water levels are being collected in the vicinity of the study. These data are being collected through programs with the North Dakota State Water Commission, and with US Geological Survey funds. There will be a mutually beneficial exchange of data between the programs.

3. Progress Through 1978:

All (4) stream gaging stations have been installed and were operational in time for the spring runoff. All streams of the area were sampled for chemical analysis and several for the determination of sediment concentration during the spring runoff. Meteorological instrumentation will be in place by midsummer to begin collection of data for use in the watershed models.

The first round of drilling is scheduled to begin in July. A total of 9,000 feet will be drilled and some 34 observation wells will be installed. Most of the wells will be sampled for chemical analysis by the end of the 1978 field season. Water-level data from the wells will be used in the ground-water modeling effort. A preliminary two-dimensional model has already been formulated and experimented with.

4. Distribution of Funds:

Salaries	\$36,601
Travel	8,433
Contractural Services	14,993
Supplies and Equipment	1,987
Laboratory Costs	5,493
Data Processing, including Computer Costs	<u>3,493</u>
Total	\$71,000

5. Reports: Basic records for surface-water quantity and surface-water quality stations will be published in the U.S. Geological Survey annual series "Water Resources Data for North Dakota" or as an appendix to an interpretive report. Basic records for ground-water levels and ground-water quality stations will be available to BLM and other interested parties and as an appendix to the interpretive report. The interpretive report on the hydrologic evaluation of strip mining and reclamation in the Wibaux-Beach area is scheduled for review by April 1979 and will probably be published in the Water Resources Investigation series of the U.S. Geological Survey.

The surface-water hydrologic model will probably take 5 years or more to develop (planned under EMRIA funds).

C. Rattlesnake Butte

1. Objectives: In response to the Interior Department's recent call for leasing nominations of Federal coal lands, most eligible tracts within the Dickinson deposit were submitted by mining concerns for consideration of their leasing potential. The interest manifest in the Dickinson field indicates a possibility of future development. This paper proposes an investigation to evaluate the probable hydrologic impacts of that potential development in an area of interest to the Bureau of Land Management. Depending on the hydraulic properties and the areal continuity of the lignite and adjacent aquifers, many of these water sources could be diminished or obliterated.

Of particular significance to the city of Dickinson would be the effects on the Heart and Green Rivers. The Heart River is impounded 1 mile west of Dickinson and serves as the city's water-supply reservoir. The Bureau of Reclamation is currently studying the feasibility of creating a water-supply reservoir on the Green River in anticipation of a future shortage.

The primary objectives will include assessment of the ground-water flow system and its chemical characteristics, determination of surface-water flow magnitudes and frequencies, chemical quality, and sediment concentration and load.

By defining the hydrologic regime of the study area, a second objective will be satisfied -- the establishment of a historical data base with which to monitor changes in the system as mining proceeds. The ultimate objective is to develop the capability of making reasonably accurate projections of the hydrologic effects resulting from the various physical treatments imposed by surface mining. Management agencies would then be able to utilize this predictive tool to augment their decision-making processes.

2. Approach: Such operational components of the total hydrologic regime as infiltration and percolation, evapotranspiration, changes in storage in the unsaturated zone, and the various modes of exchange between shallow subsurface and surface-water systems will be quantitatively assessed. This will allow for appropriate perspective placement of each component in the overall system. Implementation of programs and instrumentation necessary to quantify all segments and pathways of the hydrologic cycle and to discern the nature of and the mechanisms operative on the quality of its water will be one of the early emphases of the project.

The data collected will be used in conjunction with digital models to gain a thorough knowledge of the hydrologic system. Quantitative hydrologic parameters will be refined and data deficiencies will be identified with the aid of the model. This refine-simulate-refine process will be repeated until the model is calibrated and satisfactorily represents the real system. It will then be available for estimating the hydrologic effects of various land treatments within the study area.

3. Relationship to Other Closely Associated Non-EMRIA Funded Activities: The Rattlesnake Butte area is part of the Dickinson deposit which is one of the deposits that will be covered by the hydrologic reconnaissance studies under ND-070F, which as started in FY 75 and is funded by the US Geological Survey. The data collection under ND-070F will be of value to the present study. Inasmuch as the ultimate objective of ND-070F is to provide an in-depth appraisal of the hydrologic effects of mining for each of the identified strippable deposits, the Beulah Trench study will result in a savings in the eventual overall cost of ND-070F.



Data on streamflow, sediment loads, quality of water, and ground-water levels are being collected in the vicinity of the study. These data are being collected through programs with the North Dakota State Water Commission, the Environmental Protection Agency, and Corps of Engineers, and the US Geological Survey funds. There will be a mutually beneficial exchange of data between the programs.

4. Distribution of Funds:

Salaries	\$ 59,186
Travel	23,614
Laboratory Costs	5,660
Contractual Services	32,500
Equipment and Supplies	26,140
Data Processing, including Computer Costs	<u>1,200</u>
Total	\$151,000

5. Reports: Basic records for surface-water quantity and surface-water quality stations will be published in the US Geological Survey annual series "Water Resources Data for North Dakota" or as an appendix to an interpretive report. Basic records for ground-water levels and ground-water quality stations will be available to BLM and other interested parties and as an appendix to the interpretive report. The interpretive report on the hydrologic evaluation of the Rattlesnake Butte area is scheduled for review by April 1981 and will probably be published in the Water Resources Investigation series of the US Geological Survey.

II. Reconnaissance Studies

A. Investigation of the Ground-Water Resources of McKenzie County, North Dakota:

1. Objectives: McKenzie County contains large deposits of Federally owned coal and is potentially one of the major coal producing counties of the State. Much of the lignite is saturated and in fact is the host rock for aquifers that supply water for domestic and farm use in much of the county. In view of its mining potential and the importance of ground-water supplies to the residents, it is important that ground-water information be obtained prior to mining so that the probable effects of mining may be predicted and so that land reclamation after mining be undertaken to reconstruct the aquifer systems.

The purpose of this study is to survey and document the quantity, quality, and movement of ground water in McKenzie County. In addition, this study will provide fundamental data

and quantitative interpretations upon which water-management decisions can be made for municipal, domestic, industrial, and irrigation uses. Specific objectives are to (1) determine the location, extent, and nature of major aquifers, including estimates of storage and potential yield; (2) evaluate the chemical quality of the ground water; (3) identify current and potential use of ground water; and (4) estimate and attempt to quantify the movement of ground water, including sources of recharge and discharge.

2. Approach: This is a relatively comprehensive study of the ground-water resources. The methods of study are categorized by the following activities: (1) project planning; (2) water records; (3) test drilling; (4) chemical quality of water sampling and analyses; (5) aquifer tests and special studies; (6) data compilation and analysis; and (7) report preparation.
3. Relationship to Other Closely Associated Non-EMRIA Funded Activities: The study proposed herein will be jointly funded through EMRIA funds, US Geological Survey, US National Park Service, North Dakota State Water Commission, North Dakota Geological Survey, and the Water Management District of McKenzie County.

There are no other funded projects in the county at this time.

4. Distribution of Funds:

Salaries	\$4,593
Travel	<u>1,807</u>
Total	\$6,400

Additional Funds:

US Geological Survey	\$93,125
US National Park Service	7,700
North Dakota State Water Commission	19,600
North Dakota Geological Survey	10,000
McKenzie County Water Management District	19,600

5. Reports: Three reports will be published cooperatively by the North Dakota State Water Commission and the North Dakota Geological Survey. Part I will describe the surface geology; Part II will be a compilation of basic data, including data on existing wells and test holes; Part III will be an interpretative report describing and evaluating the ground-water resources of the county.



# NORTH DAKOTA

## LIST OF WATER QUALITY PARAMETERS

### Monthly

<u>Field</u>	Discharge, ft <sup>3</sup> /s	SW only
	Temperature, °C	
	pH	
	Specific Conductance	
	Dissolved Oxygen	SW only
	Oxygen, percent saturation (calculation)	

### Laboratory

Alkalinity (tot as CaCO <sub>3</sub> )	
Bicarbonate	
Calcium, Diss	
Chloride, Diss	
Residue, Diss at 180° C	
Residue, Calc Sum	
Residue, Diss Ton/Aft	SW only
Residue, Diss Ton/day	SW only
Fluoride, Diss	
Hardness, Noncarb	
Hardness, Total	
Magnesium, Diss	
Silica, Diss	
SAR	
Sodium, Diss	
Sodium, Percent	
Sulphate, Diss	
Nitrogen Tot as N	SW only
Nitrogen Tot as NO <sub>3</sub>	SW only
Nitrogen Total KJD as N	SW only
NO <sub>2</sub> + NO <sub>3</sub> as N Tot	SW only
Nitrogen, NH <sub>4</sub> as N Tot	SW only
Nitrogen, Diss Org as N	
Nitrogen, NH <sub>4</sub> as N Diss	
Nitrogen, Diss KJD	
Phosphorous, Tot as P	SW only
Phosphorous Tot Diss as P	
Carbon, Diss Org	
Carbon, Susp Org	SW only
Susp. Sed Conc.	SW only

### Quarterly

Susp. Sed.	Size Analysis	SW only
Bed Matl.	Size Analysis	SW only
	BOD, 5-day	SW only
	Aluminum	
	Arsenic	
	Barium	
	Boron	
	Bromide	(Ground Water only)
	Cadmium	
	Chromium	
	Copper	
	Iron	
	Lead	
	Lithium	
	Manganese	
	Mercury	
	Molybdenum	
	Selenium	
	Strontium	
	Zinc	

### Annual Radio Chem

#### Analysis Schedule 473

Gross Alpha, Beta -- Dissolved  
Gross Alpha, Beta -- Suspended  
Radium 226 by Radon,  
Uranium Fluorometric

NOTE: Ground-water samples will be taken annually.

**Oklahoma**



I. Introduction

A. Purpose and Scope:

BLM is charged with the responsibility of assessing the probable water resources impacts and reclamation capabilities of any area under Federal jurisdiction in which surface mining for coal might occur. In order to meet this responsibility, a variety of hydrologic data are required. In Oklahoma, these data are being provided by (1) hydrologic monitoring in selected areas and (2) hydrologic modeling of Coal Creek basin near Lehigh. In addition, hydrologic data are also being generated by the Survey's monitoring program at twelve sites in the coal field and collection of sediment data at these twelve sites under the auspices of the Oklahoma BLM office.

As of April 1978, areas near Blocker, Rock Island, Red Oak and Stigler have been identified as having high potential for mining of Federal coal. Data collection activities, begun in 1976, are going on in the Blocker and Rock Island areas but these activities need to be increased because mining may begin in the very near future. For the same reason, a data collection program is needed in the Red Oak and Stigler areas. Hydrologic data collection in the Spiro area, begun in 1976, should be discontinued because the area has low mining potential. An interim report describing the data collected for the Blocker, Rock Island, and Spiro areas through FY 78 will be prepared. The target date for delivery of this report to BLM is March 1979.

As part of the hydrologic modeling program, additional data on ground water in Coal Creek basin is needed because a sandstone aquifer lying above the principal coal bed (lower Hartshorne coal) is the source of supply for the town of Lehigh (population 300) and because ground water is discharged into the surface water system through flowing wells and artesian springs. Field data indicate that the chemical quality of ground water differs from one well to another and may be, in part, related to the depth from which the water is derived. If the ground-water phase of the hydrologic system and its interrelation with the surface-water phase is to be understood, the hydraulic characteristics of the rocks, particularly water-bearing sandstones must be determined. These characteristics can be determined only by test drilling and aquifer testing. In addition, information is needed on changes in chemical character of ground water with depth and with distance from the outcrop of the aquifer. To provide this kind of data, five test holes should be drilled; three of the holes would be about 500 feet deep and two would be about 1,000 feet deep.

## II. Hydrologic Monitoring

A. Sample Frequency: All sites included in the monitoring phase of the program will be sampled according to the following schedule:

1. Monthly -- common constituents and nutrients
2. Semi-monthly -- field parameters, dissolved and total metals, and sediment
3. Semi-annually -- bottom materials

B. Suites of Analyses: See Attachment A.

C. Blocker Area:

1. Blue Creek near Blocker
  - a. Continue surface water gaging station.
  - b. Collect samples as scheduled.
2. Blue Creek tributary near Blocker
  - a. Make instantaneous discharge measurement at time samples are collected.
3. Mathuldy Creek near Crowder
  - a. Make instantaneous discharge measurement at time samples are collected.
4. Maintain ground-water level recorder near Blocker.
5. Maintain rain gage near Blocker.
6. Recheck field parameters of water from selected wells.

D. Rock Island Area:

1. James Fork near Hackett, AR
  - a. Collect samples as scheduled.
2. James Fork near Williams, OK
  - a. Make instantaneous discharge measurement at time samples are collected.
3. Maintain ground-water level recorder near Williams.

4. Maintain rain gage near Williams.
5. Recheck field parameters of water from selected wells.

E. Red Oak Area:

1. Brazil Creek below proposed mining area (T6N, R22E, Section 2, SW1/4, SW1/4)
  - a. Install and maintain gaging station.
  - b. Collect samples as scheduled.
2. Brazil Creek above proposed mining area (T6N, R21E, Section 17, SW1/4, SW1/4)
  - a. Make instantaneous discharge measurements when samples are collected.
3. Rock Creek above proposed mining area (T6N, R21E, Section 15, NE1/4, SW1/4)
  - a. Make instantaneous discharge measurement when samples are collected.
4. Field inventory of all accessible water wells.
5. Collect 10 ground-water samples for laboratory analysis.
6. Install and maintain ground-water level recorder if suitable well is available.
7. Install and maintain rain gage.

F. Stigler Area:

1. Taloka Creek below mining area (T9N, R21E, Section 9, SW1/4, NW1/4)
  - a. Install and maintain gaging station.
  - b. Collect samples as scheduled.
2. Taloka Creek above mining area (T10N, R20E, Section 36, NE1/4, SE1/4)
  - a. Make instantaneous discharge measurement when samples are collected.
3. Field inventory of all accessible water wells.



4. Collect 10 ground-water samples for laboratory analysis.
5. Install and maintain ground-water level recorder if suitable well is available.
6. Install and maintain rain gage.

### III. Hydrologic Modeling (Coal Creek Basin)

#### A. Stream-Water Quality:

1. Coal Creek near Lehigh, OK
  - a. Operate continuous water-quality monitor for pH, specific conductance, dissolved oxygen, and water temperature.
  - b. Operate automatic water sampler to collect suspended-sediment samples daily and during selected runoff events.
  - c. Collect water samples monthly and during selected runoff events for analysis of common constituents and nutrients.
  - d. Collect approximately 40 water samples, divided between runoff events and baseflow, for metals analysis.
  - e. Collect biological samples quarterly for analysis of benthic organisms, periphyton, chlorophyll, and phytoplankton.
  - f. Collect water samples quarterly for organic carbon analysis.
2. Coal Creek tributaries at T1S, R10E, Section 28, NE1/4, NW1/4 and T1S, R10E, Section 16, SW1/4, SW1/4.
  - a. Operate single-stage sediment samplers.
  - b. Collect water samples quarterly for analysis of field parameters, common constituents, nutrients, metals, and organic carbon.
  - c. Collect biological samples quarterly for analysis of benthic organisms, periphyton, chlorophyll, and phytoplankton.

B. Surface-Water Flow Regime:

1. Coal Creek
  - a. Operate surface-water gaging station.
  - b. Operate crest-stage gage.
2. Coal Creek tributaries
  - a. Operate crest-stage gages.
  - b. Make periodic stream discharge measurements.

C. Ground-Water Quality:

1. Continue well and spring inventory including field parameters analysis and laboratory analysis for dissolved iron, chloride, and sulfate.
2. Collect water samples from approximately 15 wells for analysis of field parameters, common constituents, nutrients, and metals.

D. Ground-Water Aquifer Properties:

1. Operate ground-water level recorder at T1S, R10E, Section 27, NW1/4, NE1/4.
2. Make annual mass water-level measurement.
3. Make seepage measurements during both summer and winter low flow periods.
4. Test drilling program.
  - a. Drill five test holes, three to approximately 500 feet and two to approximately 1000 feet.
  - b. Test each aquifer in each test hole.
  - c. Collect water samples for analysis of field parameters, common constituents, nutrients, and metals.
  - d. Collect drill cutting samples for mineralogic and other analyses from each test hole.
  - e. Complete each well for use as an observation well.
  - f. Run geophysical logs on each test hole.

E. Climatological Information:

1. Operate climatological data station at T1S, R10E, Section 21, SE1/4, NW1/4.
  - a. Continuous air temperature.
  - b. Continuous relative humidity.
  - c. Continuous solar radiation.
  - d. Continuous precipitation.
  - e. Continuous wind speed and direction.
2. Operate three additional continuous precipitation gages.
3. Make periodic depth-soil moisture measurements at approximately 30 sites.

F. Inventory ponds and make sediment-depth measurements and analyze water for field parameters at selected ponds.

G. Report Plans:

1. Daily stream discharges and water-quality data will be published in the "Water Resources Data for Oklahoma" annual report.
2. Additionally, a basic data report presenting all data collected will be prepared.
3. Interpretive reports on major work phases will be started.
  - a. Geology.
  - b. Test drilling, geophysical logging, and aquifer tests.

H. Distribution of Funds:

Blocker Area

Laboratory Analyses	\$26,923
Gaging Station	5,273
Ground-Water Level Recorder	810
Rain Gage	810
Ground-Water Parameters	1,623
Field Work	8,791
Equipment & Supplies	270
Total	\$44,500

Rock Island Area

Laboratory Analysis	\$20,135
Ground-Water Level Recorder	810
Rain Gage	810
Ground-Water Parameters	1,210
Field Work	5,000
Equipment & Supplies	135
Total	\$28,100

Red Oak Area

Laboratory Analyses	\$30,902
Gaging Station	5,128
Gaging Station - Operate	6,747
Ground-Water Level Recorder	1,754
Rain Gage	1,214
Ground-Water Inventory	2,294
Field Work	7,422
Equipment & Supplies	539
Total	\$56,000

Stigler Area

Laboratory Analyses	\$24,461
Gaging Station - Install	5,135
Gaging Station - Operate	6,756
Ground-Water Level Recorder	1,756
Rain Gage	675
Ground-Water Inventory	2,702
Field Work	5,945
Equipment & Supplies	270
Total	\$47,700

Lehigh Area

Laboratory Analyses	\$31,738
Gaging Station	8,106
Water-Quality Monitor	6,750
Automatic Water Sampler	8,106
Climatological Station	6,754
Ground-Water Level Recorder	810
Rain Gages	2,430
Field Work	20,256
Equipment & Supplies	6,750
Total	\$91,700

#### IV. Sediment Monitoring

- A. As part of the EMRIA program in the Oklahoma coal field, sediment samples will be collected at 12 USGS monitoring sites listed below:

Brushy Creek near Haileyville  
Caston Creek at Wister  
Coal Creek near Spiro  
Deer Creek near McAlester  
Fourche Maline near Wilburton  
Holi-Tuska Creek near Panama  
Morris Creek at Howe  
Muddy Boggy Creek at Atoka  
Owl Creek near McCurtain  
Peaceable Creek near Haileyville  
Red Oak Creek near Red Oak  
Sugarloaf Creek near Monroe

Automatic sampling equipment will be used at 10 of the sites. Observers will be used at Caston Creek at Wister and Muddy Boggy Creek at Atoka.

Sediment samples from all 12 sites will be delivered to the WRD office in Oklahoma City where sediment concentrations will be determined. The number of samples from each site per year is estimated at 400. Six samples per year from each site will be sent to a laboratory outside the Oklahoma District for size analysis.

The estimated cost of the sediment program for FY 79 is as follows:

Personnel		
Field		\$ 7,000
Laboratory		21,100
Records		15,500
Computer Processing		700
Supplies & Equipment		2,100
Size Analysis (outside lab)		5,600
Travel & Per Diem		<u>2,800</u>
	SUB-TOTAL	\$54,800
Contractor	approximately	<u>25,000</u>
	TOTAL	\$79,800

# ATTACHMENT A

## Analytical Suites

### Field Parameters

00400	pH
00095	Specific conductance
00010	Water temperature
00300	Dissolved oxygen
	Instantaneous water discharge

### Common Constituents -- DISSOLVED

00955	Silica
00915	Calcium
00925	Magnesium
00930	Sodium
00935	Potassium
00410	Alkalinity
00940	Chloride
00945	Sulfate
00950	Fluoride
70300	ROE at 180° C
00800	Color
00076	Turbidity

### Nutrients

	<u>Dissolved</u>	<u>Total</u>
Nitrogen, Kjeldahl	00623	00625
NO <sub>3</sub> + NO <sub>2</sub>	00631	00630
Phosphorous	00666	00665

### Metals

	<u>Dissolved</u>	<u>Total</u>
Aluminum	01106	00105
Arsenic	01000	01002
Boron	01020	01022
Cadmium	01025	01027
Chromium	01030	01034
Copper	01040	01042
Iron	01046	01045
Lead	01049	01051
Manganese	01056	01055
Mercury	71890	71900
Molybdenum	01060	01062
Zinc	01090	01092

### Calculated Values

Sodium Adsorption Ration (SAR)  
Total hardness  
Dissolved solids tons/acre feet

### Bottom Materials

00626	Nitrogen, Kjeldahl
00633	NO <sub>3</sub> + NO <sub>2</sub>
00668	Phosphorous
01108	Aluminum
01003	Arsenic
01028	Cadmium
01034	Chromium
01043	Copper
01170	Iron
01052	Lead
01053	Manganese
71921	Mercury
01063	Molybdenum
01093	Zinc



**Oregon**



OREGON

I. Ground Water Inventory (OR-930-4340-5273)

A. Completion of report on ground water inventory in the  
Ironsides Resource Area.

B. Funding: \$4,000



**Utah**



I. Hydrology of the Ferron Sandstone in Castle Valley and Effects of Strip Mining near Emery, Utah

A. Location: Southern Castle Valley in east-central Utah, total area about 800 square miles.

B. Objectives:

1. Determine the effects of stripping the upper confining layers of shale from the Ferron Sandstone aquifer and mine dewatering on:
  - a. Existing wells and springs.
  - b. Base flow and quality of water in streams.
  - c. Quality of water in the Ferron Sandstone.
  - d. Rates and directions of leakage between the aquifer and its confining layers.
2. Determine the effects of erosion and leaching of stockpiled overburden on the sediment, water quality, and biologic characteristics of streams.
3. Determine recharge and discharge, aquifer characteristics, and the quantity and quality of water available from the Ferron Sandstone throughout Castle Valley.

C. Approach: During FY 79 will consist of:

1. Continued literature survey and file search for previous studies done and hydrologic data collected in and near the study area, and for studies in other areas which have relevant results.
2. Continued contact with coal, oil, gas, and seismic companies and Federal and State agencies to obtain drilling and hydrologic data.
3. Inventory of springs and seepage measurements along streams that cross the Ferron Sandstone outcrop.
4. Continued streamflow, quality-of-water, precipitation, and water-level data collection.
5. Aquifer testing (and observation-well construction) at existing private and EMRIA wells.



6. Test drilling and aquifer testing to define the quantity and quality of the Ferron, and the lower marine-sandstone section of the Ferron, and the degree of interconnection between zones.
  7. Continue design and verification of a digital model of the Ferron Sandstone.
  8. Continue laboratory study of minerals leached from overburden.
- D. Report Products: An interpretative report will be prepared by September 1980.
- E. Distribution of Funds: (Salaries are included in individual items and total about \$40,000).

Planning	\$ 2,880
Data Collection	39,210
Lab Support	6,340
Computer Services	12,680
Test Drilling and Aquifer Testing	100,338
Travel	7,492
Report Preparation	<u>23,060</u>
Total	\$192,000

## II. Hydrologic Study of the Uinta Basin

- A. Location: Southeastern Uinta Basin; about 2,400 square miles.
- B. Objective: To collect streamflow data in FY 79 and continuing contingent upon annual appropriations.
- C. Approach:
1. Operate streamflow gaging station at one site:
 

09306900 White River at mouth near Ouray, Utah, in SE1/4SE1/4NW1/4 Sec. 2, T9S, R20E, Uintah County, Lat. 40°03'54", Long. 109°38'06".
  2. Collect daily sediment samples at the gaging site shown under item 1 and calculate daily suspended-sediment loads.
- D. Report Products: Information will be included in normal Basic-Data reports of the Utah District. BLM may request the data directly if needed.

E. Distribution of Funds:

Salaries	\$ 4,450
Sediment Observer	2,810
Travel	1,390
Supplies and Equipment	140
Laboratory Support	2,717
Data Processing and Reporting	<u>693</u>
Total	\$12,200

III. Hydrology of the Price River Basin, with Emphasis on Areas Underlain by Coal

- A. Location: Price River drainage basin approximately 1,500 square miles, with most emphasis in the areas of the basin underlain by coal in the Book Cliffs and Wasatch Plateau in Carbon, Emery, Utah, Wasatch, Sanpete, and Duchesne Counties.
- B. Objective: To determine the effects of present and proposed coal mining on the hydrology of the Price River Basin. Specifically to determine the effects of coal-mining (including the effects of existing and potential land subsidence) on surface-water quantity, quality, and biology; ground-water recharge, movement, discharge, and quality; and sediment yields.
- C. Approach: During FY 79 will consist of:
1. Literature survey and search of the files of Federal and State agencies to compile data previously collected in the area that will be useful in this study.
  2. Contacting coal and oil companies to obtain drilling data and available hydrologic data, including data on the occurrence of water in existing coal mines.
  3. Inventory of wells and springs and collection of samples of surface and ground water for chemical analysis.
  4. Determining water-bearing zones in the stratigraphic section using information obtained in (1), (2), and (3).
  5. Making seepage measurements along streams to indicate reaches gaining water from or losing water to the ground-water reservoir.
  6. Designing a data-collection network to supplement present and past sites for collection of surface-water, ground-water sediment, water quality, and precipitation data.
  7. Determining the need for test-drilling to obtain ground-water data; and if deemed necessary, design a drilling and testing program and prepare specifications for a contract.

8. Conducting aquifer tests on existing wells to determine hydraulic characteristics of aquifers.

D. Report Products: A basic-data report and an interpretive report will be prepared by September 1981.

E. Distribution of Funds:

Salaries	\$ 47,464
Travel	7,514
Laboratory Support	5,780
Supplies and Equipment	2,890
Computer Services	1,387
Install Gaging Stations	17,341
Test-Drilling or Miscellaneous Construction	<u>24,624</u>
Total	\$107,000

VI. Hydrology of the Central Wasatch Plateau, Sanpete, Sevier, and Emery Counties, Utah (UT-930-4110-1125)

A. Location: Central Wasatch Plateau, between Cottonwood Creek and IH-70, an area of about 600 square miles.

B. Objectives:

1. Define the extent of aquifers, areas of recharge and discharge, and the quantities and quality of water in storage.
2. Determine the variability in quantity and quality of streamflow and stream biology.
3. Estimate volumes of runoff and flood-prone areas within areas of development.
4. Determine sources of current and potential water supply.
5. Predict, within constraints of available data, effects of coal mining on the water resources and stream biology.

C. Approach: During FY 1979 will consist of:

1. Literature and file search to locate all available data and studies.
2. Well and spring inventory, including sampling for chemical analysis.
3. Complete and test exploration holes drilled by Federal and State agencies and by coal and petroleum companies. This will furnish data on water levels, hydraulic properties, and water quality in an adjacent to the coal-bearing zones.

4. Conduct seepage runs on streams and aquifer tests on existing wells.
  5. Sample surface water for chemical analysis and sediment and make an aquatic-biota survey.
  6. Install rain gages to collect precipitation data to use in correlating rainfall and runoff. Delineate areas, within coal-development areas, that will be inundated by floods of various recurrence intervals.
  7. Study the occurrence of water in existing underground coal mines.
- D. Reports: The Bureau of Land Management requires a report by October 1, 1979 summarizing knowledge obtained to that date to be used for lease stipulations and/or an EIS on the tract on North Horn Mountain. A final interpretive report will be prepared by September 1981.
- E. Distribution of Funds: (Salaries are included in individual items and total about \$55,000).

Planning	\$ 9,000
Data Collection	33,000
Central Laboratory	6,000
District Sediment Laboratory	4,000
Computer Time	1,400
Well-Completion and Aquifer-Testing	
Equipment	7,500
Travel and Per Diem	7,000
Report Preparation and Review	19,000
District Support	<u>20,100</u>
Total	\$107,000

V. Hydrologic Monitoring, Bonneville Salt Flats and Pilot Valley Playa, Utah (UT-930-4130-2225)

- A. Location: In western Tooele County, Utah; about 100 square miles on the western side of the Great Salt Lake Desert and in Pilot Valley.
- B. Objectives: To continue monitoring changes in water levels, chemical quality of brine, and the salt-crust surface, as a follow-up to a study of the hydrology of the area completed in FY 1977 (UT-123).
- C. Approach:
1. Semi-annual measurement of water levels in about 25 wells and annual measurements in 2 wells.

2. Annual collection of water samples for chemical analysis from about 19 wells.
  3. Semi-annual photographs of salt crust at 5 sites.
  4. Semi-annual measurement of salt thickness at 3 sites.
- D. Reports: Annually, tables of water levels and chemical analyses and a map showing water-level changes will be submitted to BLM.
- E. Distribution of Funds:

Salaries, travel and per diem, equipment and supplies, chemical analyses, and District and Division support.

\$7,600

**Wyoming**





# WYOMING

## I. Hydrologic Monitoring in Energy Resources Area of Wyoming

### A. Powder River Basin:

1. Location: Powder River basin in northeastern Wyoming.
2. Objectives:
  - a. Determination of runoff characteristics for watersheds in or near areas of extensive deposits of coal.
  - b. Determination of the physical effects of coal mining and land reclamation on surface runoff and ground-water recharge.
  - c. Determination of the chemical and biologic quality of surface water and sediment transport in streams.
3. Procedures:
  - a. Operate the following stream gages:

Station Number and Name	SW	QW	Sed	Total
06317000 Powder River at Arvada			\$ 5,890	\$ 5,890
06324000 Clear Creek near Arvada			1,160	1,160
06365300 Dry Fork Cheyenne River near Bill	\$ 3,800	\$ 3,740	640	8,180
06386000 Lance Creek near Spencer	3,800	3,740	640	8,180
06425720 Belle Fourche River below Rattlesnake Creek, near Piney	3,800	3,740	3,750	11,290
06425780 Belle Fourche River above Dry Creek, near Piney	3,800	3,740	3,750	11,290
06426500 Belle Fourche River below Moorcroft	3,800	5,460	1,160	10,420
TOTALS	\$19,000	\$20,420	\$16,990	\$56,410

- b. Analyze sediment samples from beds and walls of selected ephemeral stream channels for immediate information on transport characteristics of previously unsampled streams.
  4. Report Products: Publish basic data in annual report of USGS. Use the data in the preparation of interpretive reports.
- B. Green River, Great Divide, and Bear River Basins:
1. Location: Green River, Great Divide, and Bear River basins of Wyoming.
  2. Objectives:
    - a. Determination of runoff characteristics for watersheds in or near areas of extensive deposits of coal and oil shale.
    - b. Determination of the physical effects of coal mining, land reclamation, and in situ oil shale reporting on surface runoff and ground-water recharge.
    - c. Determination of the chemical and biologic quality of surface water and sediment transport in streams.
  3. Procedures:
    - a. Operate the following stream gages:

Station Number and Name	SW	QW	Sed	Total
09214500				
Little Sandy Creek above Eden	\$ 3,800	\$ 1,900	\$ 1,020	\$ 6,720
09216527				
Separation Creek near Riner	3,800	5,460	3,750	13,010
09216562				
Bitter Creek above Salt Wells Creek, near Salt Wells	3,800	5,460	1,160	10,420
09216565				
Salt Wells Creek near South Baxter	3,800	5,470	3,760	13,030
09216578				
Dry Canyon near South Baxter	1,600	4,280	640	6,520
09216750				
Salt Wells Creek near Salt Wells	3,800	5,460	1,160	10,420
09222300				
Little Muddy Creek near Glencoe	3,800	5,460	1,160	10,420

Station Number and Name	SW	QW	Sed	Total
09222400				
Muddy Creek near Hampton	\$ 3,800	\$ 5,460	\$ 1,160	\$10,420
09235300				
Vermillion Creek near Hiawatha	3,800	5,460	1,160	10,420
1002700				
Twin Creek at Sage	3,800	5,460	1,160	10,420
TOTALS	\$35,800	\$49,870	\$16,130	\$101,800

- b. Analyze sediment samples from beds and walls of selected ephemeral stream channels for immediate information on transport characteristics of previously unsampled streams.

4. Report Products: Publish basic data in annual reports of USGS. Use the data in the preparation of interpretive reports funded by the USGS.

C. Hanna Basin:

1. Location: Hanna Basin in south-central Wyoming.
2. Objectives:
  - a. Determination of runoff characteristics for watersheds in or near areas of extensive deposits of coal.
  - b. Determination of the physical effects of coal mining and land reclamation of surface runoff and groundwater recharge.
  - c. Determination of chemical and biologic quality of surface and ground water and sediment transport in streams.
3. Procedures:
  - a. Operate the following stream gages:

Station Number and Name	SW	QW	Sed	Total
06630300				
Big Ditch near Coyote Springs	\$ 3,800	\$ 3,740	\$ 640	\$ 8,180
06630330				
North Ditch near Coyote Springs	3,800	3,740	640	8,180

Station Number and Name	SW	QW	Sed	Total
06634990				
Hanna Draw near Hanna	\$ 3,800	\$ 3,740	\$ 640	\$ 8,180
TOTALS	\$11,400	\$11,220	\$1,920	\$24,540

b. Analyze sediment samples from beds and walls of selected ephemeral stream channels for immediate information on transport characteristics of previously unsampled streams.

4. Report Products: Analyze data and prepare progress reports as significant data become available. Publish basic data in annual reports of USGS. Use the data in the preparation of interpretive reports funded by the USGS.

D. Other Basins:

1. Location: Big Horn and North Platte basins.

2. Objectives:

- a. Determination of runoff characteristics for watersheds in or near areas of extensive deposits of coal.
- b. Determination of the physical effects of land use on surface runoff and ground-water recharge.
- c. Determination of the chemical and biologic quality of surface and ground water, and sediment transport in streams.

3. Procedure:

- a. Operate the following stream gages:

Station Number and Name	SW	QW	Sed	Total
06207510				
Big Sand Coulee at Wyoming-Montana State line	\$ 2,550	\$ 660	\$ 5,040	\$ 8,250
06256900				
Dry Creek near Bonneville	3,800	860	3,530	8,190
06267400				
East Fork Fifteenmile Creek near Colter		1,010	7,040	8,050

Station Number and Name	SW	QW	Sed	Total
06267900				
Middle Fork Fifteenmile Creek near Worland		\$1,010	\$ 1,410	\$ 2,420
06268500				
Fifteenmile Creek near Worland	\$ 3,800	1,010	9,600	14,410
06628800				
Sage Creek near Saratoga	2,550	980	700	4,230
TOTALS	\$12,700	\$5,530	\$27,320	\$45,550

4. Report Products: Publish basic data in annual reports of USGS. Use the data in the preparation of interpretive reports funded from other sources.



## **Office of Public Lands Hydrology**





## PUBLIC LANDS HYDROLOGY PROGRAM

### I. Hydrologic Modeling

1. Approach: In FY 79, the Public Lands Hydrology Program (PLHP) will be coordinating their work with the hydrologic modeling effort of the Water Resources Division in eight basins: North Dakota (2), Montana (1), Colorado (2), New Mexico (1), Oklahoma (1), and Alabama (1). In FY 79, PLHP will be collecting data in the basins in Colorado and North Dakota to test model parameters of soil moisture storage, vegetation characteristics, overland flow, infiltration, soil detachability, and geomorphic characteristics, such as slope, drainage density, and relief. These data will be used to develop and test runoff and sediment transport models in the experimental basins. The process of developing and testing the model in the field with data from the eight experimental basins is expected to take 5 years. The models that are to be developed will permit the prediction of the effects of mining and land reclamation on the water resources of the affected area.
2. Reports: In order to make information available to the Bureau of Land Management on a timely basis for environmental assessment studies and leasing, PLHP will prepare a progress report on at least one of the eight experimental basins each year. This progress report will include the following products:
  - a. Vegetation and soils map together with interpretations to show premining conditions and postmining potential for reclamation.
  - b. Source-area sediment-yield maps that represent present conditions.
  - c. Infiltration rates, overland flow, and sediment-yield data from rainfall simulator experiments.
  - d. The narrative of the report will discuss plant species that would naturally succeed on a site following a natural catastrophe such as wild fire, species that have been used to replace natural vegetation when shrubs and trees have been eradicated for range improvement, and, as appropriate, recommendations of practices that can optimize soil moisture.

3. Distribution of Funds:

Salaries	\$110,090
Travel	9,605
Vehicles	6,005
Supplies and Equipment	1,200
Data Processing and Computer Costs	<u>1,800</u>
Total	\$128,700

4. The approximate distribution of work in this project, in terms of funds per state, is as follows:

Alabama	\$ 10,000
Colorado	40,000
Montana	25,500
New Mexico	12,700
North Dakota	10,000
Oklahoma	25,500
Wyoming	<u>5,000</u>
Total	\$128,700

II. Rainfall-Simulation (YA-350-4340-5225)

1. Approach: During FY 79, rainfall-simulation investigations by the Geological Survey will be concentrated in Prairie Dog Creek basin, Montana and in a small watershed in the front range area which is to be established for development of hydrologic modeling techniques.

At the Prairie Dog Creek basin, the rainfall simulator will be used to generate runoff, sediment, and infiltration data from a sufficient number of plots to define the characteristics of the major hydrologic types. Rainfall-application rates from the simulator will be 2 inches per hour for a duration of 45 minutes on an area of about 4,000 square feet. The following measurements will be made at each site:

- a. Runoff hydrograph.
- b. Sediment discharge.
- c. Basin slope.
- d. Soil type and texture.
- e. Antecedent moisture.
- f. Vegetative cover.

g. Percent silt and clay.

h. Percent bare ground.

The small watershed in the frong range area is to be equipped with semi-permanent instrumentation for collection of data on natural events as well as standard simulated events. These data will be used to help determine the equivalence of natural and simulated events and the transferability of data from small plots to larger watersheds using rainfall-runoff models. The small plot data using the rainfall simulator is to be used in conjunction with data from the larger watershed, which will be obtained by the Rainfall-Runoff Modeling Group of USGS. In addition to the standard measurements made on simulation sites, data will be obtained on measurement of the wetting front in the simulation plots.

B. Reports: The BLM will be provided with a report on the information obtained on the runoff, sediment yield, and infiltration data obtained at the EMRIA study area, Prairie Dog Creek. In addition, the USGS will produce an annual progress report on model development using the rainfall simulation data.

C. Distribution of Funds:

Salaries	\$27,000
Travel	3,000
Vehicles	2,250
Supplies and Equipment	2,000
Data Processing & Computer Costs	<u>750</u>
Total	\$35,000



## **Channel Geometry**





## STREAMFLOW CHARACTERISTICS RELATED TO CHANNEL GEOMETRY OF STREAMS IN COAL LEASE AREAS

Estimates of streamflow characteristics are presently required for hydrologic studies and assessing the impact of coal mining in central and western United States. In the regions where it is difficult to relate streamflow characteristics to precipitation, drainage area, and other measurable basin characteristics, additional methods are needed. Channel geometry is one such method. Streamflow characteristics have been related to channel geometry of streams in much of western United States through many individual studies, mostly statewide. Results of the studies, as indicated by standard errors of estimate, have been good for the most perennial streams and excellent for perennial mountain streams. These relations probably can be transferred to other areas, but some verification in each area will be necessary to assure this. Results are generally unknown for ephemeral streams because most study areas had too few long-term ephemeral gaging stations to develop reliable relations. Relations of the streamflow characteristics to channel geometry of ephemeral streams will need to be developed using available gaging stations data in western United States.

The principal objectives of the proposed study would be directed specifically to the strippable coal areas in central and western United States and are: (1) to verify the transferability of the existing relations of streamflow characteristics to measurable dimensions of channel geometry and channel material characteristics of perennial streams; (2) to develop new relations of streamflow characteristics to measurable dimensions of channel geometry and channel material characteristics of ephemeral streams; and (3) to investigate the feasibility of estimating sediment transport characteristics for perennial and ephemeral streams.

The following approach is to be used: Data should be collected at gaging stations with 20 or more years of record on perennial streams in or near the major coal areas to verify existing relations that have been developed from the two Missouri River basin studies or other statewide studies. Existing relations could then be used directly or with adjustments if necessary. The width and average depth of the channel cross section for the active channel and the bankfull stage should be measured. Bed- and bank-material samples should be collected for particle-size analysis. A measurement of channel slope should be included. At all sites additional data that may prove pertinent, such as channelization, vegetation, presence of bedrock, and evidence of recent flooding should be collected.

Information sufficient to develop statistically significant regression equations should be collected from suitable ephemeral sites throughout the western United States. Several studies should be made, aimed primarily at developing methods for estimating the flow characteristics at ungaged sites. Measurements should be made of the dimensions of channel geometry that have proved successful in other studies, i.e., width and average depth of the channel cross section between in-channel depositional

bars, the active channel, and the bankfull stage. Data collection should include sampling and particle-size analyses of bed and bank material in order to adjust the discharge-geometry relations depending on the size characteristics of the channel alluvium. This technique has been used successfully for perennial streams of Kansas and the Missouri River basin and is presumed applicable to ephemeral channels as well. A measurement of the channel slope should be included. Consideration also should be given to the possible influence of varying communities and densities of riparian vegetation. One to three cross sections should be measured at each selected site. Sites should be selected at or near gaging stations with continuous record for 20 or more years. The data should be collected by hydrologists that have had experience in channel geometry. One or more representatives from each USGS District of BLM Office could participate in the field work. The plan will save time in locating the gaging station and a good reach of channel and provide excellent training.

Suspended-sediment data, reservoir and stock-pond surveys, and other established methods of evaluating sediment movement in arid and semi-arid climates should be compiled. These data should be correlated with channel-geometry and channel-material information to determine if methods for estimating sediment discharge can be developed.

#### REPORT PLANS

The results will be open-filed and duplicated for early availability as soon as practicable after the end of the second year of the 2-year study. The final results of the study will be reported in the Water Supply Paper series. A progress report (open-file) will be furnished at the end of the first year (9/79).

<u>COST ESTIMATES</u>	<u>FY 79</u>	<u>FY 80</u>
Data Collection	\$ 56,700	\$ 53,300
Travel	10,700	8,000
Laboratory Analyses	10,700	8,000
Data Analyses	13,300	18,700
Report Preparation	2,700	5,300
Support to other Districts	<u>15,900</u>	<u>6,700</u>
Total	\$110,000	\$100,000

## **BRANCH OF COAL RESOURCES**



## ANNUAL WORK PLAN

October 1, 1978 through September 30, 1979

The General Agreement between the Bureau of Land Management (BLM) and the Geological Survey (GS), dated August 1974, is considered an integral part of the Work Plan.

### PURPOSE AND SCOPE OF PROGRAM

1. Assistance by the Branch of Coal Resources of the GS to the Energy Minerals Rehabilitation Inventory and Analysis (EMRIA) program administered by the BLM during the period October 1, 1978, through September 30, 1979, includes the following work and study elements.
  - A. Study of the geology of coal and related rock sequences in the areas selected for studies of reclamation potential. Provide guidance and support for drilling and sampling activities.
  - B. Select samples for determination of organic composition and major, minor, and trace-element constitution of coals that may be mined in the near future, and, where possible, for determination of the major, minor, and trace-element constitution of the rock sequence that is closely associated with the coals and might be disturbed during recover of the associated coals.
  - C. Estimate the quantity of coal resources present in the reclamation study areas according to standardized definitions, criteria, and methods that have been adopted to maintain validity and comparability of estimates.
  - D. Evaluate the determined geologic and analytical information on the coal and associated rock sequence in the context of defining the particular factors that might affect exploration, development, mining, reclamation, and utilization planning.
  - E. Prepare reports describing the work and study program conducted in reclamation study areas for inclusion in applicable reports of the EMRIA Reclamation Studies Series.

Reports specifically include quantitative and qualitative assessments of the coal resources based on geologic studies and analytical information, both new and pre-existing. The format has generally included discussion of the origin and classification of coals; detailed quantitative estimates classified by degree of geologic assurance, thickness and overburden categories, and legal land subdivisions; tabular presentation of standard coal analytical results, major, minor, and trace-element analytical results, and comparisons with other western coals; and discussions of the coal quantity and quality with particular attention to those elements that can affect recovery and utilization.

Other report elements may be included in reports on some reclamation study areas; or may be separately published by the GS when desirable or necessary.

The reports will be submitted to BLM or its authorized agent approximately 6 months after submittal of samples to the laboratory.

Any or all of the above listed work and study elements may be conducted in any particular reclamation study area depending on arrangements with other cooperating agencies about work and reporting division and responsibilities. The list above, 1.A. through 1.E., is not intended to be exclusive of related work or studies for which desirability and/or responsibility may be established during the course of work programs conducted in the reclamation study areas. The work programs to be conducted in specific reclamation study areas by the Branch of Coal Resources are listed in the following state-by-state summaries.

NORTH DAKOTA

2. Reclamation Study Area, Beulah Trench

- A. Location: Mercer County; all of Section 6 and parts of Sections 4 and 8, T144N, R88W, and parts of Sections 14, 22, 26, and 34, T145N, R88W.
- B. Objectives and Procedures: Twenty-four samples have been submitted for analysis.
- C. Report Products: A report on the quantitative and qualitative coal resources of the reclamation study area will be prepared for inclusion in the EMRIA Reclamation Studies Series. The contents of the report will be approximately as outlined in item 1.E.
- D. Funding:

Salaries	\$1,500
Travel and O/E	
Analytical Costs	
(24 X \$800 - \$3,000) <u>1/</u>	<u>          </u>
Total	\$1,500

1/ \$3,000 in FY 78 Work Plan, \$16,200 absorbed.



3. Reclamation Study Area, Rattlesnake Butte;

- A. Location: Stark County; all of T140N, R98W, except Sections 1, 12, 13, 24, 25, and 36; E1/2 T140N, R99W; Sections 29, 30, 31, and 32, T141N, R97W; Sections 25, 26, 27, 28, 29, 32, 33, 34, 35, and 36, T141N, R98W.
- B. Objectives and Procedures: Samples of coal and associated rocks will be accepted for determination of organic composition and major, minor, and trace-element constitution. Approximately 25 samples will be submitted for analysis.
- C. Report Products: A report on the quantitative and qualitative coal resources of the reclamation study area will be prepared for inclusion in the EMRIA Reclamation Studies Series. The contents of the report will be approximately as outlined in item 1.E.
- D. Funding:

Salaries	\$ 5,000
Travel and O/E	
Analytical Costs	
(25 X \$800 - \$4,000) <u>2/</u>	<u>16,000</u>
Total	\$21,000

2/ \$4,000 in FY 78 Work Plan.

MONTANA

4. Reclamation Study Area, Prairie Dog Creek:

- A. Location: Powder River County; all or parts of Sections 5, 7, 8, 9, 10, 14, 15, 16, 17, 18, 21, 25, 26, and 31.
- B. Objectives and Procedures: Provide support for drill program to obtain cores of the coal and overlying rocks. Samples of coal and associated rocks will be accepted for determination of organic composition and major, minor, and trace-element constitution. Approximately 25 samples will be submitted for analysis.
- C. Report Products: A report on the quantitative and qualitative coal resources could be prepared for inclusion in the EMRIA Reclamation Study Series. The report would be part of the Work Plan for FY 79. The contents of the report would be approximately as outlined in item 1.E.
- D. Funding:

Salaries	\$ 5,000
Travel and O/E	1,000
Analytical Costs	
(25 X \$800 - \$4,000) <u>3/</u>	<u>16,000</u>
Total	\$22,000

3/ \$4,000 in FY 78 Work Plan

COLORADO

5. Reclamation Study Area, Lay Creek:

- A. Location: Moffat County; Sections 25, 26, 27, and 28, T8N, R93W.
- B. Objectives and Procedures: Samples of coal and associated rocks will be accepted for determination of organic composition and major, minor, and trace-element constitution. Approximately 25 samples will be submitted for analysis.
- C. Report Products: The results of analyses of samples cited in 5.B. will be used to assess the quality of the coal in the study area. The resulting report will include comparison with other nearby coals and complete standard tabulation.
- D. Funding:

Salaries	\$ 2,500
Travel and O/E	500
Analytical Costs	15,000
(25 X \$800 - \$5,000) <u>4/</u>	<hr/>
Total	\$18,000

4/ \$5,000 in FY 78 Work Plan

6. Reclamation Study Area, McCallum:

A. Location: Jackson County

B. Objectives and Procedures: Samples of coal and associated rocks will be accepted for determination of organic composition and major, minor, and trace-element constitution. Approximately 25 samples will be submitted for analysis.

C. Report Products: The results of analyses of samples cited in 6.B. will be used to assess the quality of the coal in the study area. The resulting report will include comparison with other nearby coals and complete standard tabulation.

D. Funding:

Salaries	\$ 2,500
Travel and O/E	500
Analytical Costs (25 X \$800)	<u>20,000</u>
Total	\$23,000

NEW MEXICO

7. Reclamation Study Area, Kimbeto:

- A. Location: San Juan County; Section S1/2 19, 30, T22N, R9W; Section 4, 5 S1/2 6, 7, 8, 9, S1/2 10, SW1/4 11, SW1/4 13, 14, 15, 16, 17, 18, N1/2 19, 22, 23, 24, 25, n1/2 26, NE1/4 27, T22N, R10W; Section 12, T22N, R11W.
- B. Objectives and Procedures: The geologic map of the area has been completed and supplied to the principal investigator. All samples (25) have been submitted to Branch of Coal Resources.
- C. Report Products: A report on the quantitative and qualitative coal resources is being prepared for inclusion in the EMRIA Reclamation Studies Series. The report may, if necessary information becomes available, be completed in FY 78, but some of the processing would probably be done in FY 79.
- D. Funding:

Salaries	\$1,500
Travel and O/E	
Analytical Costs	
(25 X \$800 - \$2,000) <u>5/</u>	<u>500</u>
Total	\$2,000

5/ \$2,000 in FY 78 Work Plan, \$18,000 absorbed

8. Reclamation Study Area, Ojo Encino:

- A. Location: McKinley County; Sections 2, 3, 4, 5, N1/2 7, part of Section 9, T19N, R5W: parts of Sections 33 and 34, S1/2 35, part of Section 36, T20N, R5W.
- B. Objectives and Procedures: Provide geologic guidance and support for the drill program to obtain cores of the coal and associated rocks. A preliminary geologic map of the reclamation study area has been prepared and submitted to the principal investigator. Approximately 25 samples will be submitted for analysis.
- C. Report Products: A report on the quantitative and qualitative coal resources will be prepared for inclusion in the EMRIA Reclamation Study Series. The contents of the report would be approximately as outlined in item 1.E. The preliminary geologic map will be modified to include information developed as a consequence of the drill program and will be supplied to the principal investigator for inclusion in the Series report.
- D. Funding:

Salaries	\$ 5,000
Travel and O/E	1,000
Analytical Costs	
(25 X \$800 - \$4,000) <u>6/</u>	<u>16,000</u>
Total	\$22,000

6/ \$4,000 in FY 78 Work Plan

UTAH

9. Reclamation Study Area, Emery:

- A. Location: Changed from the area proposed for FY 77; includes parts of Sections 22, 23, 26, and 34, T22S, R6E; Section 3, T23S, R6E; Section 5, T24S, R6E, and parts of surrounding area.
- B. Objectives and Procedures: Provide geologic support and guidance for drill program. Accept approximately 30 samples of coal for analysis from about 16 different coal beds in the re-selected area.
- C. Report Products: A report on the quantitative and qualitative coal resources of the reclamation study area will be prepared for inclusion in the EMRIA Reclamation Study Series. The contents of the report will be approximately as outlined in item 1.E.
- D. Funding:

Salaries	\$ 5,000
Travel and O/E	1,000
Analytical Costs	
(25 X \$800 - \$2,000) <u>7/</u>	<u>22,000</u>
Total	\$28,000

7/ \$2,000 in FY 78 Work Plan



OKLAHOMA

10. Reclamation Study Areas, Arkoma Basin:

- A. Location: Arkoma Basin of central-eastern Oklahoma.
- B. Objectives and Procedures: Accept approximately 30 samples of coals for determination of organic composition and major, minor, and trace-element constitution.
- C. Report Products: A qualitative coal assessment of the sampled coal beds will be prepared with standard tabulation and comparison with the same and other coals in the general area.
- D. Funding:

Salaries	\$ 2,500
Travel and O/E	1,000
Analyses (30 X \$800)	<u>24,000</u>
Total	\$27,500

ALABAMA

11. Reclamation Study Areas, Northern Alabama:

- A. Location: Ten or more areas in coal fields of northern Alabama.
- B. Objectives and Procedures: Accept approximately 45 samples of coals for determination of organic composition and major, minor, and trace-element constitution.
- C. Report Products: A qualitative coal assessment of the sampled coal beds will be prepared with standard tabulation and comparison with similar coals in the southern Appalachians.
- D. Funding:

Salaries	\$ 2,500
Travel and O/E	1,500
Analyses (45 X \$800)	<u>36,000</u>
Total	\$40,000

EASTERN AND WESTERN SECTIONS, BRANCH OF COAL RESOURCES

12. Coordination, supervision, guidance, and support during all phases of the investigations. Includes accessory costs such as travel and other costs necessary for accomplishment of Work Plan objectives in items.

Total Funding	\$ 25,000
---------------	-----------

WORK PLAN TOTALS

Total estimated funding, items 1 through 11

Guidance, support activities, report preparation (includes salaries, travel, and other expenses).	\$ 65,000
---	-----------

Analytical Costs	<u>165,000</u>
------------------	----------------

Total	\$230,000
-------	-----------



## **BRANCH OF REGIONAL GEOCHEMISTRY**



## ANNUAL WORK PLAN

October 1, 1978 through September 30, 1979

The General Agreement between the Bureau of Land Management and the Geological Survey, dated August 15, 1974, is considered an integral part of the Work Plan.

### PURPOSE AND SCOPE OF PROGRAM

Assistance by the Branch of Regional Geochemistry of the USGS to the Energy Minerals Rehabilitation Inventory and Analysis (EMRIA) program administered by BLM includes the following work and study elements.

1. Characterize the chemical and mineralogical composition of the rock materials that are overburden to mineable coal beds in northeastern Oklahoma. Analyses will include total element chemistry as well as chemistry of solution extracts of the rock materials. A report will be submitted to BLM evaluating these chemical and mineralogical data in the context of defining any potential rehabilitation problems.
2. Continued chemical extract work and interpretative analysis on samples collected from the Energy study area, Utah. Emphasis will be placed on the chemical characterization of certain geologic units in the context of defining any potential rehabilitation problems. The potential transfer of this information to other areas in the west where coals of Cretaceous age are to be mined will be evaluated.
3. BLM personnel have requested continued consultative guidance for work in the Black Warrior Basin, Alabama.

### FUNDING

	<u>Oklahoma</u>	<u>Utah</u>	<u>Alabama</u>
Salaries	\$ 8,000	\$ 4,000	\$ 2,000
Travel and OE	3,000	1,000	500
Chemical Analyses	60,000	14,000	
Computer	1,500	500	
Overhead	<u>4,000</u>	<u>1,500</u>	<u>          </u>
Total	\$76,500	\$21,000	\$ 2,500
GRAND TOTAL	\$100,000		





214

[illegible]

(Continued on reverse)

DATE DUE

**GAYLORD**

PRINTED IN U.S.A.

BLM LIBRARY  
SC-324A, BLDG. 50  
DENVER FEDERAL CENTER  
P. O. BOX 25047  
DENVER, CO 80225-0047

